



# RESEARCH AT STELLENBOSCH UNIVERSITY

SHOWCASING RESEARCH EXCELLENCE

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1918 · 2018

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## FOREWORD: PROF WIM DE VILLIERS

Every year, our Division for Research Development publishes a research report showcasing research conducted at Stellenbosch University (SU) and its impact on society. The focus this time around is a very special one – to look back not just on the most recent year, 2017, but on the past 100 years in light of our Centenary in 2018.

In commemorating this milestone, we are celebrating great achievements and groundbreaking discoveries since the formation of SU out of Victoria College in 1918. In the process, we recognise everyone who has helped to mould SU and cement its reputation as one of Africa's leading research-intensive universities, with significant global standing.

However, SU is part of a particular context. Over the course of the past century, it performed its higher education role within the various political, socio-economic, cultural and educational developments in South Africa at the time, including the apartheid period. The University has since acknowledged its contributions to the injustices of the past, and committed itself to redress and development.

Research at SU followed a similar trajectory, as illuminated by Baumert<sup>1</sup> in a recent dissertation for her PhD jointly awarded by Stellenbosch and Leipzig universities. In 1982, one of the first comparative studies on research in the natural sciences by UNISA physicist EC Reynhardt found that South African academics did far less research than their counterparts in industrialised countries.

Reynhardt also found that English-medium universities in South Africa “comprehensively outperformed” their Afrikaans-medium counterparts in terms of research – and SU (which has since become a multilingual institution, also using English as a language of instruction and research) was placed at the very bottom of the list!

Baumert points out that it came as a big shock to SU, because what had held sway up to that point was “the historical self-image” of this University as “a place of excellence”. But in reality the institution, “having been constructed ... around the notion of the volksuniversiteit (‘people’s university’) ... binding itself solely to one ethnically oriented cultural community... therefore limit(ed) itself for quite some time to identity politics more so than focusing on

academia. Its ‘identity-driven’ insular character additionally resulted in a ‘measuring by own standards’ rather than in comparing oneself to other institutions in terms of the quality and quantity of academic achievements.”

What happened next is very instructive. As pointed out by Botha<sup>2</sup> in the SU’s Centenary book, there was a noticeable shift at SU to focus on two things: improving the research function of the University, and purposefully internationalising the University.

There were deliberate steps in this direction under the consecutive SU rectors Professors Andreas van Wyk (1993 to 2001), Chris Brink (2002 to 2007) and Russel Botman (2007 to 2014). It also found expression in SU’s major policy documents over this period. Now, we want to maintain that momentum going forward. We are working on a new vision and strategic framework for the University – and a strong research focus is one of the non-negotiables.

A task team has consulted widely and identified core focus areas for research at SU. There is broad agreement that SU should be known for relevant, interdisciplinary research with purpose and impact.

We want to expand our participation in collaborative research networks on our continent and in the rest of the world. We want to use technological innovation to enhance the learning and research experience. And we will follow an interdisciplinary approach informed by the desire to solve pressing local and global challenges.

My appreciation to everyone involved in research at SU, not in the least to the person leading our efforts in this regard, Prof Eugene Cloete, Vice-Rector: Research, Innovation and Postgraduate Studies. In the reporting period, he received a National Science and Technology Forum (NSTF)/South32 award for his outstanding contribution to research and innovation in South Africa.

If one looks at our research activities and outputs – as reflected in this report – we clearly already have a solid foundation to build on. From this point, we can only go forward together.

**Prof Wim de Villiers**, Rector and Vice-Chancellor

<sup>1</sup> Baumert, Stefanie C. 2014. *University politics under the impact of societal transformation and global processes: South Africa and the case of Stellenbosch University, 1990-2010*. Thesis (PhD), Stellenbosch University and Universität Leipzig. <http://hdl.handle.net/10019.1/195959>

<sup>2</sup> Botha, Jan. 2018. *‘Akademiese werk aan die US van 1918 tot 2018’*. Universiteit Stellenbosch 100: 1918–2018. Universiteit Stellenbosch.

## INTRODUCTION: PROF EUGENE CLOETE

Postgraduate studies and research were from the outset part of the academic work of the University. In 1923, SU awarded its first doctoral degree. During this early period a total of 25 doctoral degrees were awarded, including 11 in 1930 and 18 in 1942, the highest number in a single year. In 2017, an all time record of 305 doctoral degrees were awarded.

SU prides itself as a research-intensive university. In this regard research excellence is a defining factor. This is achieved by clustering of expertise and critical mass to create theme-based, problem-focused research centres including centres of excellence (CoEs). These research centres undertake interdisciplinary theme-based research projects and have strong academic leadership surrounded by a team of researchers, postdoctoral fellows and postgraduate students. Some of these research units are many decades old (e.g. the Bureau for Economic Research, established in 1944). The University is further home to seven CoEs, four of which are established by the National Department of Science and Technology (DST). However, much of the research of SU is conducted in academic departments. So, while illuminating, one cannot only focus on these centres and institutes to get a sense of the scope of our research activities.

The University's researchers are seen as leaders in a number of areas, including engineering electromagnetics; nano-structured functional materials; pavement engineering; postharvest technology; photonics – ultrafast and ultra-intense laser science; posttraumatic stress disorder (PTSD); genetic tailoring of biopolymers; advanced macromolecular architectures; human rights law; scientometrics; experimental petrology; aeronautical dynamics; economics of social policy; property law; energy research; meat science; genomics to nutrionomics; mathematical and theoretical physical biosciences; integrated wine sciences; intellectual property; agronomy; TB biomarkers; animal TB; wastewater management; science communication; mechanistic modelling of health and epidemiology; mycobacteriology; quantum, optical and atomic physics; social-ecological systems and resilience; sociology of land, environment and sustainable development; gender politics; paediatric TB; integrative

skeletal muscle physiology; and biology and biotechnology.

Research funding is the life-blood of excellent research and hence SU continued to build a sustainable research enterprise by third stream income (contract research). The realised yield for 2017 was R1,086 million and reflects the revenue realised in the specific year as a part of multiyear contracts.

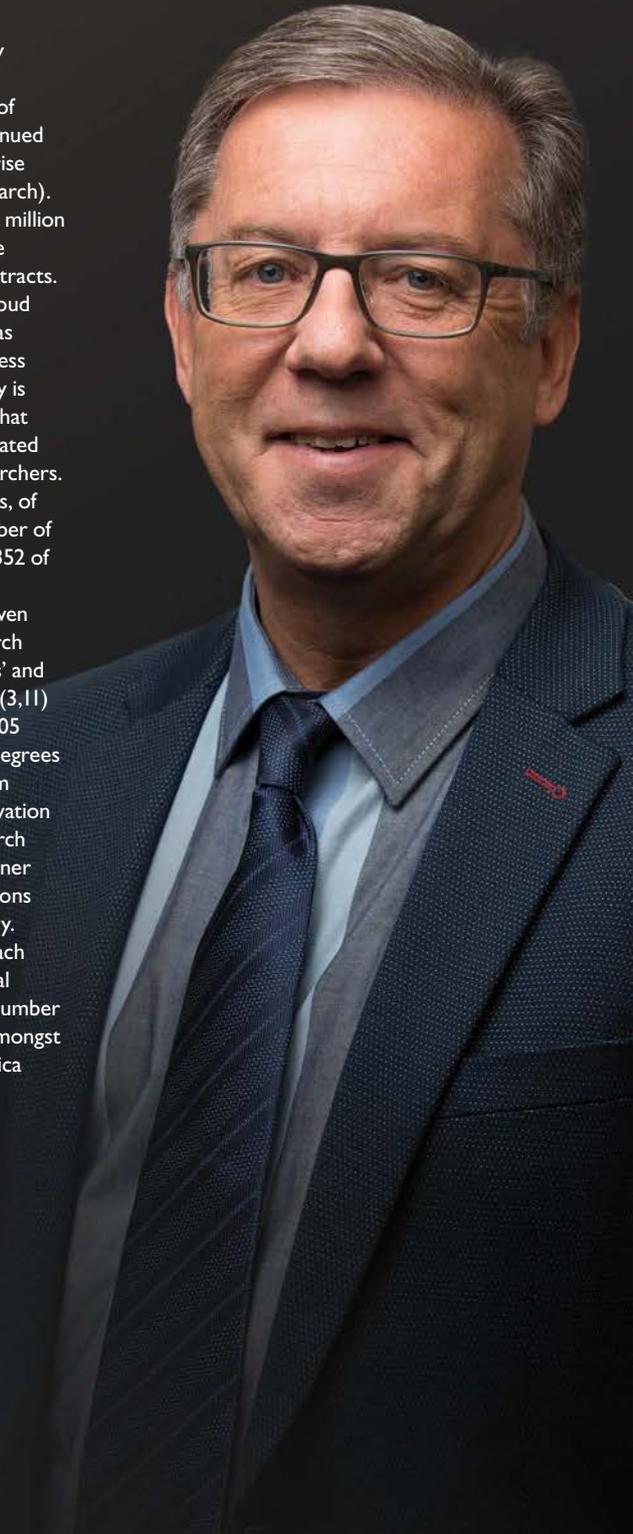
SU has good reason to be very proud of its record, reputation and standing as a leading research university. The success of SU as a research-intensive university is put into perspective when it is noted that by 2017, the University had 432 NRF-rated researchers, 14 of them A-rated researchers. The university hosts 44 research chairs, of which 25 are SARCHI chairs. The number of postdoctoral fellows in 2017 reached 352 of which 44% were international.

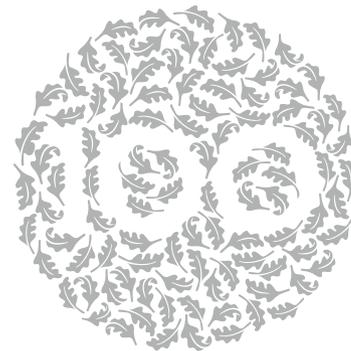
In 2017, SU again (for six out of seven years) had the highest weighted research output (publications, research masters' and doctoral degrees awarded) per capita (3,11) in South Africa. A record number of 305 doctoral degrees and 1 600 master's degrees were awarded of which 47% were from previously disadvantaged groups. Innovation forms an important part of SU's research success. Since 2014, SU is the frontrunner regarding the number of PCT applications (108) in South Africa, including industry.

It has been the University's approach to take a nuanced view on international rankings. Nevertheless, over the last number of years, SU has consistently ranked amongst the top three universities in South Africa irrespective of the ranking agency.

*Eugene Cloete*

**Prof Eugene Cloete**  
Vice-Rector: Research, Innovation and  
Postgraduate Studies





## A HISTORICAL PERSPECTIVE ON RESEARCH AT STELLENBOSCH UNIVERSITY 1918-2018\*

### THE EARLY PERIOD

It was in the context of the years following the Anglo-Boer War (1899-1902) and the First World War (1914-1918) that Stellenbosch, as a new university, had to position itself. During that time, various cultural and scientific ventures were launched to promote science, such as the establishment of Onderstepoort (1908), the South African Institute for Medical Research (1912) and the Kirstenbosch Botanical Gardens (1913). The first three independent universities in South Africa were established in 1918, including Stellenbosch University (SU). Organised academic research did not originate at the universities – it was rather organised through government departments and laboratories. The universities were initially concerned with teaching and the reproduction of knowledge, while the industrial requirements of the First World War (1914-1918) inaugurated state-sponsored research. After the war, the university sector grew and new academic posts were created, leading to more specialisation and professionalisation. During the inter-war period, the Carnegie Corporation played a major role to develop the South African government's capacity for educational and social research and provided funding for museums and libraries, including the library of Stellenbosch University.

During this time, eight faculties were established at SU: (1918), Natural Sciences (1918), Education (1918), Agriculture (1918), Theology (1920), Law (1921), Commerce and Administration (1923), and Engineering (1941). In 1923, SU awarded its first doctoral degree (in Science). A number of South Africans chose to study further at universities overseas after they had graduated at a college or university in South Africa. The university's oldest research institute, the Bureau for Economic Research, was established in 1944. During the period 1918-1947

SU professors published articles in journals such as the *Quarterly Journal of the Geological Society of London*, *Geological Magazine*, *Transactions of the Royal Society of South Africa*, *Annals of Botany*, *Nature*, *Zeitschrift für Züchtung Reihe B*, *Tierzüchtung und Züchtungsbiologie einschließlich Tierernährung*, *Proceedings of the Linnean Society of London*, *Review of Scientific Instruments*, *Physical Review*, *The Journal of Agricultural Science* and *Soil Science*.

Stellenbosch University envisaged itself from the outset as a full-spectrum national university with a research mandate, allocating a high priority to postgraduate education.

### THE ERA OF APARTHEID (1948-1993)

Through the *Extension of University Education Act* of 1959 and the *Fort Hare Transfer Act* of 1959, black colleges and universities were created for different ethnic groups. Stellenbosch alumnus, Constitutional Court Judge Edwin Cameron, remarked: "Some of the most devastating aspects of apartheid played out in our schools and universities. Segregated schools deprived the majority of South Africans of educational advancement for generations. The inequity was written into law and enforced by the official organs of state. At university level, enrolment was overwhelmingly white and the shadow of government interference loomed large over the makeup of the student body."

This experiment in social engineering had the effect that most universities in the country became isolated and inward looking. They were out of step with higher education developments elsewhere in the world since the middle of the 20th century, such as massification, globalisation and the advent of the knowledge society, and somewhat later, the advances in information and communications technology. Despite the countervailing forces of apartheid and these global trends, a fair number

of SU scientists continued to publish in international journals and to participate in knowledge production and dissemination. While the academic boycott definitely had an inhibiting impact on researchers at Stellenbosch, it did not lead to a complete isolation.

During the apartheid years, four additional faculties were added to Stellenbosch University, Medicine (1956), Forestry (1956), Military Science (1961) and Dentistry (1968).

A significant academic development at SU during the 1970s was the establishment of research institutes in a range of different fields of study. These institutes played a major role to stimulate research and to facilitate better access to external funding resources. From the 1980s and onwards, new research units were added including the Institute for Physics (1983), the Institute for Biotechnology (1984), the Unit for Research in Mathematics Education (1984), the Institute for Oral Health (1987), the Bureau for System Engineering (1987), the Centre for Contextual Hermeneutics (1987), the Centre for Applied Ethics (1988) and the Centre for International and Comparative Politics (1992). New impetus was given to research with the establishment of the Stellenbosch 2000 fund during the 1980s, with the specific aim to develop Stellenbosch as a leading centre for postgraduate education and research.

However, there is also an interesting story of demise, recovery and remarkable success to be told. In 1985, the Foundation for Research Development (FRD) of the Council for Scientific and Industrial Research published the results of the first round of the ranking of South African researchers in science, technology and engineering. Stellenbosch ended at the bottom of the list of South African universities; it did not have any A-rated researchers, only three B-rated researchers, and 20 C-rated researchers. Senior research managers provide three reasons why SU did not do well in the

first FRD-ratings: (a) at the time SU scientists published mostly in Afrikaans, so their work was not known broadly internationally; (b) scientists at other universities associated some of the SU researchers with a measure of bluster; they were engaged with the politics and cultural issues of the apartheid era and they did not orientate their work to the broader national and international context, and (c) while there have been excellent researchers at SU all along, some of them were academic purists primarily engaged in science for the sake of knowledge and they did not play the bibliometric game of trying to publish as many journal articles as possible. They were more orientated to the continental tradition in Europe which was – at that time – less competitive than the Anglo-American tradition.

The first ratings were a wake-up call for Stellenbosch. Under leadership of Prof WT Classen (the vice-rector then responsible for academic affairs) an imaginative and comprehensive strategy for research development was designed and implemented. It was articulated in successive five-year action plans, and when the international world opened up again for South African scholars and scientists after the release of Nelson Mandela in

1990, the internationalisation strategy became a key dimension of the research development plan. All these activities soon started to bear fruit, and during the next phase in its history SU developed into one of the leading research universities in South Africa and on the African continent.

#### THE DEMOCRATIC ERA (1994–2018)

Today SU is proud of its record, reputation and standing as a leading research university, as illustrated, inter alia, by its master's and doctoral graduates and research publications.

Among the reasons for the growth in master's and doctoral graduates are the impact of the subsidy formula (implemented in 2005), SU's success with the South African Research Chair Initiative (SARChI) funded by the National Research Foundation, the quality of the research environment created and maintained by all the faculties, and the introduction of many imaginative postgraduate programmes.

The success of SU as research-intensive university is put into perspective when it is noted that by end 2017, the University had 432 NRF-rated researchers, 14 of them A-rated researchers. Currently, SU hosts 43 research chairs of which 25

are SARChI chairs and seven Centres of Excellence, and has had the highest research output (publications, research master's and doctoral degrees awarded) per capita in South Africa for eight consecutive years. Since 2014, SU has been the frontrunner in South Africa regarding the number of Patent Cooperation Treaty (PCT) applications in South Africa, including industry. The University is a founding partner of the African Research Universities Alliance (ARUA) launched in 2015.

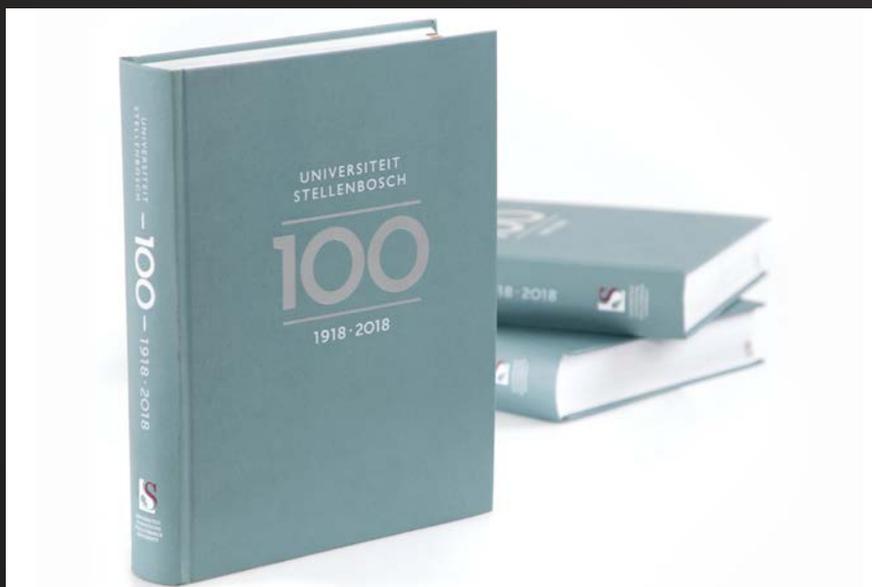
The success of SU's internationalisation initiatives is illustrated by the increase in its international cooperation agreements (from 89 in 2005 to 246 in 2017), the increase in international enrolments, and initiatives such as the offering of joint master's and doctoral degrees with universities in other countries, as well as the African Doctoral Academy (ADA). From 2012 to 2017, almost five thousand doctoral students and lecturers from universities in various African countries have participated in the summer and winter schools offered by the ADA. During 2006-2016, 27% of the University's doctoral graduates and 19% of the master's graduates were international students.

#### CONCLUSION

The chequered history of Stellenbosch University's participation in the development of the South African society during this century is accompanied by many outstanding achievements and contributions that do the University proud. However, it is also characterised by its too strong and moralistic role in the development and implementation of a deeply unjust social and political dispensation during apartheid. The end of its first century as independent university is, of course, not the end of the history of Stellenbosch University. Academic transformation is an ongoing process. It is never completed. It remains on the agenda of Stellenbosch University and all the other universities – in our country and all over the world.

**Jan Botha**

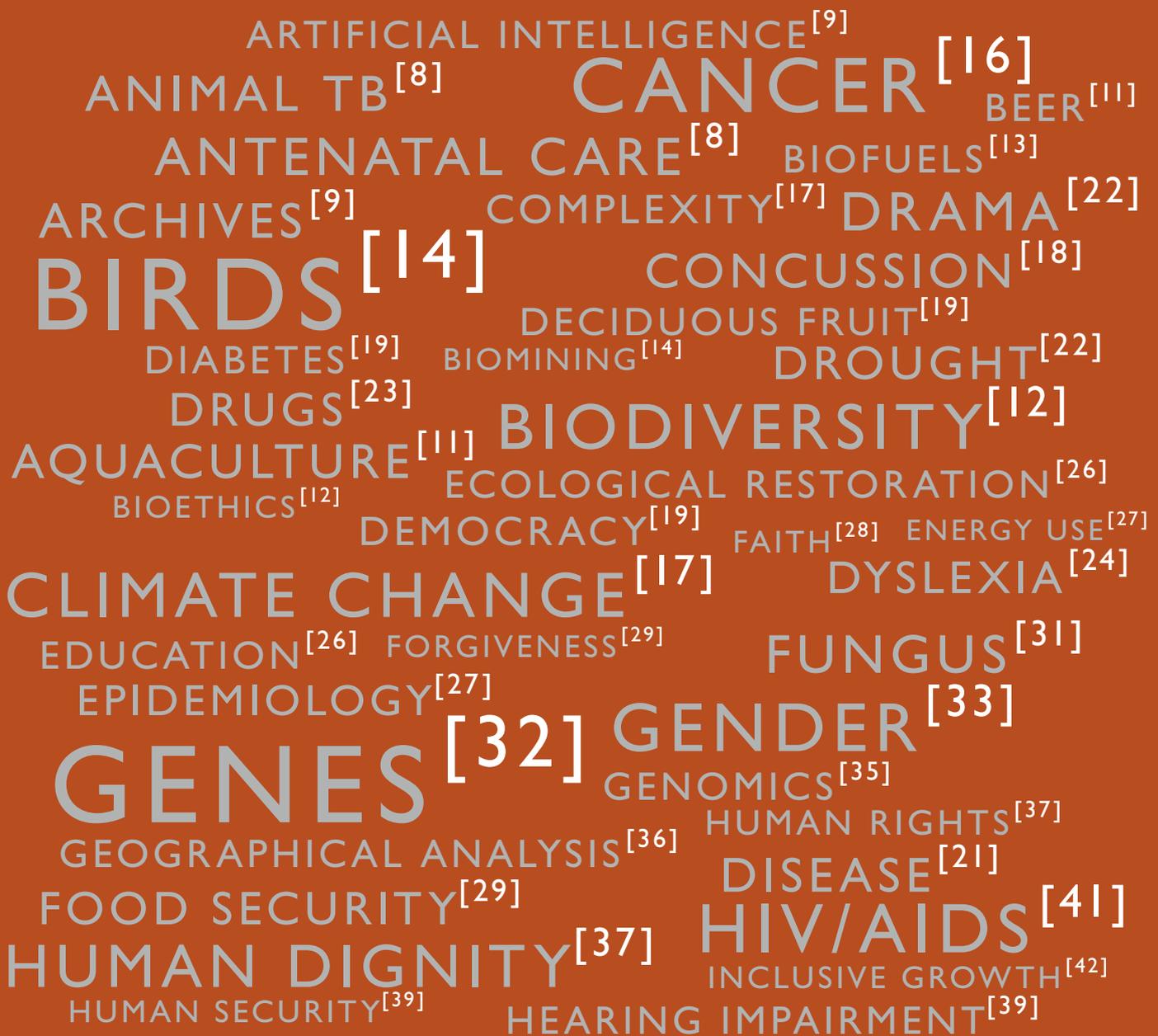
*Centre for Research on Evaluation,  
Science and Technology*



\* A summary of the chapter *Akademie werk aan die US van 1918 tot 2018* in the book *Universiteit Stellenbosch 100: 1918–2018*

## 100 RESEARCH STORIES

This is a special celebratory edition as part of the SU Centenary. In this book we highlight 100 areas where SU research has had an impact over the past 100 years. These are by far not the only research areas at SU but merely a selection to encourage further reading. Also, these 100 highlights do not in any way cover all the work done, but is intended as a snapshot of activities, some in detail, and others in general. Full articles on these areas of research can be found at <https://bit.ly/2IG797a>.





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## ANIMAL TB

Tuberculosis (TB) is a global threat to humans, domestic animals and wildlife, and research undertaken at SU aims to provide valuable insights into the biological mechanisms causing TB in animals and humans alike. Led by Prof Michele Miller, Dr Sven Parsons and Dr Leanie Kleynhans, the Animal TB Group investigates the diversity of mycobacterial infections and the consequences of this disease in South African wildlife such as lions, buffalo, rhinos and meerkats. Miller explains: “You cannot only look at one part of the picture regarding the organisms that cause TB. Humans, animals and the diseases they might share, operate in a complex system that is influenced by the environment they live in. To prevent and manage TB in animals and humans, we need to look at the whole picture, including how the pathogens change and host adaptations occur. The value of this research group is that we provide a better understanding of how TB organisms react in different animals (hosts), which will protect our natural heritage and the health and livelihoods of communities.”

Collaborating with partners in academia, government and institutions such as SANParks and Ezemvelo KZN Wildlife, the group’s work will contribute to scientific knowledge and technological and policy development.

A major focus is the development of diagnostic tools. Strategies to effectively prevent spread of disease rely on accurately identifying infected animals, and advances in blood-based tests will improve the ability to identify infected animals without invasive, costly or risky procedures.

“Similar to a skin test, an infected animal will have blood cells that react when incubated with proteins from the TB organisms. Immune responses can then be

measured in the blood sample or even in RNA from the sample,” Miller explains.

According to Miller, research on TB in wild animals is relevant for several reasons, including the health of ecosystems and the cycle of infection and reinfection that can occur. “The better our understanding of the disease, the better the management practices which can be put in place to prevent the spread of infection.”

### SA RESEARCH CHAIR IN ANIMAL TUBERCULOSIS (TB)

Prof Michele Miller, whose work forms part of TB-related research in the Faculty of Medicine and Health Sciences, holds the National Research Foundation’s Research Chair in Animal Tuberculosis. The research programme aims to increase knowledge and develop tools to understand comparative disease pathogenesis and host immune responses, identify novel biomarkers for detection of infection and disease to improve diagnostic techniques, and explore the diversity, epidemiology, and the implications and role of TB in ecosystems and at animal-human interfaces.



## ANTENATAL CARE

The Thula baba box study, a pilot study by Dr Laura Rossouw, Prof Ronelle Burger and Prof Roulof Burger from the Department of Economics, found that incentives and psycho-social support can effectively encourage earlier and more frequent access to antenatal care. Maternal mortality rates are higher in South Africa than in many other upper middle income countries, due in part to high levels of HIV prevalence. Reducing maternal mortality requires early access to anti-retroviral treatment and antenatal care.

Late access to antenatal care is a significant problem in South Africa with less than half of South African women attending antenatal clinics during their first trimester. Although research to date is limited, studies have linked delayed access to antenatal care to factors including fear and stigma related to HIV testing, late pregnancy confirmation and simply a lack of time.

Early access increases the probability of identifying problematic pregnancies and decreases the likelihood of death during childbirth related to HIV factors. Earlier access also decreases the probability of transmission of HIV from mother to child, especially in South Africa where it is estimated that 30% of pregnant women are HIV positive.

Although early access to care is a national priority, there has not been any intervention that has shown to effectively and significantly increase early access to care. The Thula baba box project examined whether additional health worker visits and incentives would encourage pregnant women to seek antenatal care. This was modelled on baby boxes introduced in Finland in the 1930s to reduce infant mortality and that is still used today. Furthermore a group of community health workers (CHW) were recruited to provide health information and psycho-social support through monthly home visits, as a supplement to standard clinical practices. During these visits, CHWs provided pregnant women with information and advice on issues such as maternal health and nutrition, the risks of alcohol and tobacco consumption, and the importance of HIV testing.

The Thula baba box intervention proved to be effective and showed that women who received the additional health worker support and were eligible for incentives accessed antenatal care about one month earlier than women in the control group. This difference was significant, especially as these women were more likely to access antenatal care four or more times during the course of their pregnancy.

The research team is applying for funding for a full trial to better understand why this intervention worked and whether it will also work in other communities.

## 3

## ARCHIVES

### ANTARCTIC LEGACY OF SOUTH AFRICA (ALSA) PROJECT

ALSA is funded by the National Research Foundation and forms part of the South African National Antarctic Programme (SANAP). South Africa, through SANAP, is the only African country with involvement in the Antarctic region, and the main aim of the project is to preserve material of South Africa's involvement in Antarctica, at the Prince Edward Islands, at Gough Island and at sea in the Southern Ocean through photographic, written, oral and other records from 1948 until today. Ria Olivier, the principal investigator, is supported by a multi-disciplinary academic team from SU, Monash University in Australia, the Iziko museums of South Africa, and the University of Cape Town.

Stories, memories, photographs and other documents including personal collections of many of South Africa's finest scientists and explorers in Antarctica and on the sub-Antarctic Islands are collected and stored at the archive repository hosted by the Stellenbosch University Library. The envisaged final product will be an online open-accessed digitised information source and a reference to all scientific material published under the auspices or funded by SANAP, and of related publications by South Africans who work outside of SANAP.

It is hoped that the database will give recognition to the role that South Africans have played in scientific, biological and meteorological research in the sub-Antarctic Ocean.

### AFRICA OPEN INSTITUTE

Africa Open Institute (AOI) is a strategic research initiative in the SU Faculty of Arts and Social Sciences that receives funding from external

grant-giving organisations, of which the Andrew W Mellon Foundation is the largest. Created in 2016, the institute developed organically from the Documentation Centre for Music (DOMUS), founded in 2005 as a unique archival, heritage and research project centred on music. AOI now incorporates DOMUS in its vision of creating the largest open-access music archive on the African continent that inspires and nurtures new generations of music scholars and innovative research projects.

Since its inception, AOI has graduated the first MMus students in jazz in the history of music teaching at SU (Kyle Shepherd and Nduduzo Makhathini), as well as the first black woman (Jacqueline Zinale Bullindah) to graduate with a PhD in music in the more than a century of institutional music tuition at the University. Dr Stephanie Vos has launched a forum for research into popular music, and an ambitious critical edition project is underway under the leadership of Honorary Professor Christine Lucia. Volkswagen Stiftung fellow Dr Lizabé Lambrechts has developed the Hidden Years archive project into an exemplary instance of scholarship and training in and through this historically important popular music archive.

AOI has also hosted smaller events, including lecture series by London Royal Academy of Music-based pianist Daniel-Ben Pienaar, who also recorded the complete piano works by Arnold van Wyk early in 2018. The institute has also supported two Sterkfontein Composers Meeting events where senior composers Paul Hanmer, Andile Khumalo and AOI Honorary Professor Michael Blake tutored young composers in interaction with the Axelsson Nilsson Duo and the Stockholm Saxophone Quartet.

Taking a keen interest in the aesthetics of protest and the #Feesmustfall student movements, AOI has also staged the You're in Chains Too solidarity concert under the auspices of the Stellenbosch Staff-Student Alliance and supported the documentation of student protest music by the Wits-based student collective Ingoma Yomzabalazo.

## 4

## ARTIFICIAL INTELLIGENCE

The presence of some form of intelligence demonstrated by machines or software agents has become commonplace, and is now central to the execution of common tasks such as internet searches, voice-controlled assistance or autonomous vehicle navigation. The increasing reach of artificial intelligence has also created exciting new research opportunities entailing the application of computational thinking and data science across the spectrum of academic disciplines.

The Centre for Artificial Intelligence Research (CAIR) is a national research initiative coordinated and managed by the Council for Scientific and Industrial Research (CSIR). The Stellenbosch University node of CAIR is hosted in the Department of Information Science, within the Faculty of Arts and Social Sciences. Its research focus is on knowledge discovery, a cross-disciplinary research field that investigates and adopts a range of AI techniques to acquire new tacit or explicit domain knowledge, often from data. CAIR-SU conducts research in the following fields:

- **algorithmics** – the study and invention of accurate, efficient and correct algorithms
- **cybersecurity** – personal, corporate and national safety and security, while preserving privacy in an increasingly digital world
- **data science** – the transformation of data into useful information to support decision making
- **knowledge representation** – the study of formal domain representation and reasoning
- **machine learning** – the study of algorithms that can learn from and make predictions on data

# NEWBORNS <sup>[58][54][44]</sup>

SU researchers are at the forefront of many global advancements, particularly in the fields of paediatric HIV and TB care. Research on early childhood care is a strategically important focus that can ensure a healthy start in life for South African children.

- **visualisation** – the study of visual representations of abstract data to reinforce human cognition

Applications of these technologies are widespread, with current collaborative research projects ranging from knowledge discovery in health informatics and wine science to the application of AI in disaster and risk management. CAIR supports SU master's and doctoral students through the Department of Science and Technology's interscholarship programme managed by the CSIR.

### SU/CSIR CHAIR IN ARTIFICIAL INTELLIGENCE

Led by Prof Arina Britz, the focal point of the Chair is the integration of artificial intelligence in tuition and research, and the creation of a student pipeline across disciplines. It strengthens research capacity in knowledge discovery within the Department of Information Science and facilitates the allocation of bursaries to postgraduate students.

## 5

## AQUACULTURE

Recently the government has identified aquaculture development as a means to address poverty and unemployment in coastal areas, and has proposed the establishment and licensing of an aquaculture development zone in Saldanha Bay. This would involve incorporating marine aquaculture, including the potential farming of bivalve (mussels and oysters), abalone, finfish and seaweed as well as land-based processing and holding facilities, hatcheries and laboratories. Earlier research by Dr David Oliver, Prof Lindy Heinecken of the SU Department of Sociology and Social Anthropology and Dr Sue Jackson on the potential growth of specifically the bivalve

aquaculture sector, however showed that a number of factors affect the development and job creation potential of this sector.

The first is the legislative and regulatory frameworks that govern aquaculture. Many farmers consider this sector to be over-regulated, which has stymied growth to date. The second is market access; a crucial factor for the development of this sector, as particularly the Asian market and even African demand is growing. The third factor is funding, which in the past was largely based on private investment; government investment has shifted the economies of scale and boosted productivity. The fourth factor is the natural environment. While the water quality on the West Coast is an asset, algal blooms and frequent storms affect production and profitability. Added to this, human induced environmental factors such as pollution and damage by local recreational sport and fishermen, drive up the costs. Last, but by no means least is the fifth factor, the availability of labour and skills. The sector is labour intensive, often demanding long hours and requiring a high degree of labour flexibility. While there is no shortage of labour, there is an acute shortage of people with boat handling skills.

Over the years, many of the challenges this sector have faced have been overcome and the potential to grow and expand exists. Current plans to extend the Saldanha Bay area to about 14 times the current size are underway and could potentially translate to anything between 3 700 to 10 000 jobs. But, warns Heinecken, such developments are never without risks. "The expansion has been met with resistance from a few strong opposition stakeholders, concerned about the environmental and aesthetic impact, as well as the effect on other sectors such as tourism and recreational sport, all of which are employment generators. Currently there is much deliberation as to what the future and expansion of aquaculture really means, in terms of the gains and losses to be made," says Heinecken.

## 6

## BEER

Agronomists and food scientists of Stellenbosch University have partnered with the multinational beverage and brewing company Anheuser-Busch InBev SA/NV (AB InBev) to tackle specific issues related to the production of barley. It will also include crops such as cassava and sorghum that is often used in beer making in many African countries.

This work is funded through the new AB InBev Research Chair in Agronomy held by Prof Nick Kotze of the SU Department of Agronomy. Bursaries worth R1 million will be provided to six undergraduate and four postgraduate MSc students. A further R1 million is being set aside to fund various research projects. According to Dr Nikki Else, Research and Development Manager: Agriculture Africa at AB InBev, it is the biggest investment yet in a South African university by AB InBev Research, or by SAB Miller Ltd, with which it merged in October 2016. Beers such as Budweiser, Stella Artois and Corona, as well as local brands such as Castle Lager, Castle Lite, Carling Black Label, Lion Lager and Hansa Pilsener count among the popular AB InBev brands.

Much of the work will focus on barley, used in malt production, which is a core ingredient in many a beer brewed worldwide. Different analytical tests will be developed to detect pre-germination in barley seeds as well as some identified barley defects. These parameters all have an influence on the eventual quality of the barley to be used to produce malt, and which influences the supply of barley within the supply chain. "We hope to put forward recommendations to predict the storage potential of pre-germinated grains, to ensure that crops are not lost completely," says Kotze.

Cassava and sorghum research will also be conducted where several varieties will be evaluated against agronomic and quality criteria. Various trial sites in Africa for selected varieties will be identified in order to determine different climatic and soil conditions on production. “Through this project we hope to provide guidelines to producers in these countries on the production techniques that work best to grow quality sorghum,” says Kotze.

### AGRICOL CHAIR IN AGRONOMY

This Chair held by Prof Nick Kotze addresses the shortage in talented agronomists in South Africa and on the continent, and helps to expand research and development in the seed industry, while increasing product knowledge and opportunities for further training.



## BIODIVERSITY

The sustainability of our human socio-ecological system depends on the function of biodiversity through the provision of ecosystem services. From clean water and fresh air to agricultural products and medicines, we thrive on nature’s generosity and ingenuity – its biodiversity and numerous entangled biological processes. “Stellenbosch is situated in a global biodiversity hotspot, the Cape Floristic Region (CFR). It is our responsibility to showcase biodiversity conservation by elucidating patterns and processes governing biodiversity in fynbos,” says Prof Cang Hui.

Hui is based in the SU Department of Mathematical Sciences, and his research team works on the interface between mathematics and biology. “As ecological processes are highly complex and adaptive, researchers rely on the simplicity of mathematical language to

explain emerging ecological patterns and their hidden mechanisms,” explains Hui.

A mathematical model developed by Hui has proven to be the single best method from several tested worldwide for estimating the diversity of plants over a large area. Hui was part of an international effort involving five research groups who were asked to test the accuracy of their modelling techniques and of all the models tested, the single best method for estimating the shape of species-area relationship was that of Hui, based on his concept of species’ occupancy ranking.

The methods will greatly aid the work of the Intergovernmental Panel on Biodiversity and Ecosystem Services. One of their aims is to provide policymakers with objective scientific assessments about the status of the planet’s biodiversity and its services to people. The Convention on Biological Diversity also requires countries to improve their monitoring and reporting of biodiversity.

Hui’s viewpoint is shared by Prof Karen Esler of the Department of Conservation Ecology and Entomology. “The spectacular botanical diversity of the CFR is ideal for studying ecological and evolutionary questions, and this biodiversity is right on SU’s doorstep. Our fundamental research also generates significant value for applied biodiversity management,” says Esler.

A recent example is the work of Dr Martina Treurnicht, one of several PhDs emerging from a long-term collaboration between SU and German partners (Prof Dr Frank Schurr), focusing on CFR biodiversity. Treurnicht investigated how environmental conditions and functional traits affect the demography, population dynamics and ecological niches of 26 serotinous Proteaceae species from the CFR. Using data sampled across species’ entire geographical ranges, the research addressed fundamental and applied perspectives in ecology and conservation biogeography, and provides insights to develop more refined strategies to conserve biodiversity in a rapidly changing world. In recognition of this work, Treurnicht was awarded the British Ecological Society’s prestigious Harper Prize in 2016.



## BIOETHICS

Stellenbosch University has over the past 20 years established itself as a centre of excellence in the field of bioethics – the study of ethical issues related to medicine and the life sciences. Bioethics is both a very old and a very new discipline. In its original manifestation as medical ethics, it has been known since the time of early Greek philosophy, which produced the Hippocratic Oath.

Its rebirth was precipitated by a number of events and phenomena. Firstly, dramatic technological advances, such as renal dialysis and transplant surgery demonstrated an unprecedented expansion of medical power over disease, which generated questions about its reach and limitations. Secondly, the Second World War and its aftermath, including the rising new tide of a human rights culture in most of the world, revealed that medical and scientific practice is by no means value free, and could easily elope into morally dubious practices, such as the experiments on human subjects by the Nazis, the dropping of atom bombs on Hiroshima and Nagasaki, the Chernobyl disaster, and, closer to home, the treatment of Steve Biko by medical practitioners. Thirdly, the enormous power of medicine to control disease and relieve suffering brought, in its wake, a growing realisation of the enormous costs associated with the execution and extension of these powers.

Under the leadership of Prof Anton van Niekerk, distinguished professor of philosophy and applied ethics, a Centre for Applied Ethics (with bioethics as core activity) was established at SU in 1990, and a highly successful master’s programme in applied ethics was created in 1996 and continues successfully to this day. Almost 20 PhD and about

65 master's students have since graduated in the field of bioethics and play important roles in bodies such as research ethics committees of the health sector all over the country and abroad today.

Key areas of research include moral issues related to the status of prenatal life, genetics, HIV/Aids, end-of-life situations, new biomedical technologies and cognitive and moral biomedical enhancement, as well as global bioethics, sexual bioethics and the significance of the death phenomenon for understanding the meaning of life.

Growing out of this work, a Centre for Medical Ethics and Law was established in 2012 in the Faculty of Medicine and Health Sciences under the leadership of Prof Keymanthri Moodley, one of Van Niekerk's earliest PhD graduates in bioethics. Endorsed by the World Health Organisation, this Centre specialises in empirical bioethics and has also offered a successful postgraduate diploma in research ethics, largely funded by the Fogarty Program of the National Institutes of Health in the USA, in conjunction with the University of North Carolina (Chapel Hill).



## BIOFUELS

### SA RESEARCH CHAIR IN ENERGY RESEARCH

This Chair, held by Prof Emile van Zyl in the SU Department of Microbiology aims to establish second-generation technologies for the production of biofuels, specifically through microbial hydrolysis and fermentation, pyrolysis and gasification of lignocellulose. The Chair has initiated interaction with role players in SA to develop partnerships to strengthen the South African biofuels initiative. More specifically, the Chair

is working to support and enable the industrial production of advanced cellulosic biofuels in South Africa, so as to lead the way in the African context. A demonstration project is underway that will utilise fibrous wastes from the paper and pulp industry for biofuels production, while a second project works with international partners to demonstrate local production of aviation biofuels from lignocellulosic waste biomass. Both of these demonstration projects will provide both the technical and economic cases to enable subsequent industrial production of advanced biofuels.

### SA RESEARCH CHAIR IN BIOREFINING

The SA Research Chair in Sugarcane Biorefining is held by Prof Johann Görgens in the SU Department of Process Engineering, and aims to broaden the range of products manufactured from available sugarcane, so as to maximise the economic value extracted beyond conventional products like sugar, electricity and ethanol. Underlying to all development work to be undertaken is a comprehensive simulation approach to assess current technology performances, technology shortcomings and potential for relevant industrial implementation. Only those processes/products that show real potential for implementation in industrial sugarcane biorefineries will be pursued for further (experimental) development work. Furthermore, the training of postgraduate students will focus on industry-ready capabilities, through a thorough understanding of sugarcane processing and the requirements for implementation of new technologies in industry.

### A CALL FOR A WORLDWIDE REFORM OF ENERGY AND RESOURCE POLICIES

Prof Oliver Ruppel of the SU Faculty of Law co-edited a book called *Roadmap for sustainable biofuels in southern Africa – Regulatory frameworks for improved development?* This 2017 NOMOS publication deals with national and international policies and regulations concerning biofuels in southern Africa. In light of the finite nature of fossil raw materials and the necessity of climate protection the book calls for a worldwide reform of energy and resource policies and laws to promote the utilisation of renewable, natural resources.

## 10

## BIOMINING

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Continuing with research begun while at the University of Cape Town, microbiologist Prof Doug Rawlings became a recognised international authority on the microorganisms capable of decomposing mineral ores and concentrates. In particular, the microorganisms used in the bio-oxidation of gold-bearing arsenopyrite concentrates prior to the recovery of the gold. This biomining process was developed in South Africa and has been used to build some very large arsenopyrite bio-oxidation plants in more than a dozen countries. For example, the arsenopyrite bio-oxidation plant at the Sansu Mine in Ghana consisted of 24 tanks of a million litres each and processed 1 000 tons of concentrate per day. Under normal operating conditions the microbial consortium is dominated by an iron-oxidising bacterium, *Leptospirillum ferriphilum*, and a sulphur-oxidiser *Acidithiobacillus caldus*. These organisms require very few added nutrients. Both organisms are acidophilic, aerobic and obtain their carbon from carbon dioxide. The *Leptospirillum* is very constrained from an energy perspective being capable of using only a single electron donor – ferrous iron. This bacterium was identified and named at Stellenbosch University.

The work carried out by many talented students and postdoctoral researchers at SU concerned several aspects of the metabolism of these organisms. This included the genes that encode for proteins that confer the very high levels of arsenic resistance that had been acquired by the bacteria that enabled their growth on arsenopyrite ores. These resistance genes were present on transposons that were

capable of jumping from one DNA molecule to another. Interestingly, the high-level arsenic resistance genes of *Leptospirillum* and *Acidithiobacillus* were related but different, implying that they had been obtained independently from the horizontal gene pool. Many of the studies were of a fundamental nature and concerned the biology of independently replicating DNA molecules called plasmids, that mediate the transfer DNA from one bacterium to another. Of particular interest was the biology of a family of highly mobile plasmids known as the IncQ plasmids and which were found to be capable of replicating in a very wide range of bacteria.

## 11

## BIRDS

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### CAN SEABIRDS DETECT INFRASOUND?

A project testing whether seabirds can detect infrasound, a very low frequency sound that is not audible to humans, tackles a facet of animal navigation that has never been explored before. The advantage of infrasound is that it can travel for very long distances and some animals such as elephants use it to communicate across large areas.

A physiological ecologist at SU, Dr Susana Clusella-Trullas is working with Jelle Assink, a geophysicist from the Royal Netherlands Meteorological Institute in The Netherlands; Samantha Patrick, a behavioural ecologist from the University of Liverpool in the UK; and Mathieu Basille, a spatial ecologist from the University of Florida in the USA in an effort to answer an intriguing question. The researchers hypothesised that seabirds use infrasound created by for example colliding waves to find distant landmarks or avoid stormy waters in the

open ocean, which provides a very new and exciting area of research.

Clusella-Trullas and postdoctoral researcher Dr Jeff Zeyl will be examining the ear structures of various seabird species, using microscopy and 3D imaging techniques to test this hypothesis. “Since some seabirds such as albatrosses travel tremendously long distances, it is possible that they use infrasound as a way to avoid storms and navigate across a vast ocean,” she explains. As seabirds are often found as by-catch in fisheries, she will be obtaining fresh carcasses from various sources to do the research. Specific structures in the inner and middle ear will be visualised, measured, and compared across multiple species. The data will be integrated by means of spatial modelling with movement and ecological data from the larger international collaborative project.

### THE DECLINE IN FOREST BIRDS

Researchers from Stellenbosch University and the Department of Environmental Affairs used data on 57 forest-dwelling species to investigate links between deforestation, species characteristics and range declines for these species over the last 20 years. A recent study, published in Bird Conservation International, showed that the ranges of 28 of South Africa’s 57 forest-dwelling bird species were declining, while those of 22 species were increasing and seven remained stable.

The findings are based on 25 years of citizen science data collected by the Southern African Bird Atlas Project. Prof Michael Cherry, a behavioural ecologist from SU and one of the co-authors, says they are particularly concerned about the disappearance of forest birds from indigenous forests in the Eastern Cape that form part of the Maputaland-Pondoland-Albany Biodiversity Hotspot. “Based on the data from the Atlas, we know that some bird species have disappeared from these forests. But we do not know whether this implies a decline in population or whether they are simply moving somewhere else,” he says.

Cherry leads a major research project, funded by the Foundational Biodiversity Information Programme that will try to ground-truth the results of





An SU project testing whether seabirds can detect infrasound tackles a facet of animal navigation that has never been explored before.

BIRDS [11]

this study in the Eastern Cape. Research partners include four South African universities and six museums, as well as Harvard University (USA). “We predict that if birds – perhaps the most mobile of animal taxa as they are able to fly relatively long distances between forest fragments – are being negatively affected by forest degradation, then other animal species are likely to be worse affected,” he says.

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## CANCER

Cancer does not distinguish between race, gender, age or socioeconomic position; it is merciless, and despite a concerted global effort, only marginal progress has been made in the war against this disease. While progress has been made in the field of oncology there still exists a need for treatments that are less taxing on a patient’s health status, while not invoking counter-evolutionary strategies from tumour cells.

The specific research focus of the cancer research group under leadership of Prof Anna-Mart Engelbrecht in the SU Department of Physiological Sciences is to explore new avenues of chemotherapy and supplementary treatments that would favour the use of lower chemotherapy concentrations with less impact on normal healthy cells, while maintaining satisfactory levels of cancer cell death. Studies have shown that: co-treatment with the commonly used chemotherapeutic drug doxorubicin and the hormone melatonin confers dual heart and skeletal muscle protection, reduces tumour size and prevents doxorubicin-induced toxicity in the heart and skeletal muscle; obesity induces resistance to chemotherapy; in breast cancer, factors released by fibroblasts

within the tumour lead to faster migration of cancer cells out of the tumour and that these cancer cells are more resistant to doxorubicin; and that the ability of breast cancer cells to pause and resist the induction of cell death following treatment is influenced by the AHNAK protein. “This was an exciting discovery and could potentially explain why certain patients respond to chemotherapy while others do not,” says Engelbrecht.

Dr Karin Baatjes, a surgical oncologist at Stellenbosch University’s Faculty of Medicine and Health Sciences (FMHS), studies postmenopausal breast cancer patients treated with aromatase inhibitors, to identify their risk of developing a decrease in bone mineral density associated with bone fractures. Baatjes believes that while factors such as calcium and vitamin D deficiency, a low body weight, smoking and a family history of osteoporosis, as well as genetic influence on drug metabolism may worsen the already elevated risk of developing osteoporosis in postmenopausal women, the quality of life of these cancer patients should not be compromised by adverse effects of effective treatment. “The ultimate aim is to identify at-risk patients prior to the start of treatment, and to adopt a responsive research approach that will lead to treatment guidelines tailored to the individual patient,” says Baatjes.

The new ultra-performance convergence chromatography (UPC2) system, funded by the National Equipment Programme (NEP), has changed the game in steroid research at Stellenbosch University. The NEP application was headed by Prof Pieter Swart and Dr Karl Storbeck, both from the SU Department of Biochemistry. Jonathan Quanson, a PhD student of Storbeck, has made a huge contribution towards the success of this new equipment. Quanson’s research investigates the role of adrenal steroid hormones in the development of castration resistant prostate cancer (CRPC). Quanson developed a high-throughput method to separate and quantify 19 structurally related androgen precursors and androgens which have been implicated in CRPC. The sensitivity and selectivity achieved by this method

makes it ideally suited for multiple in vitro and in vivo applications, such as investigations into CRPC and other hormone dependent cancers. According to Quanson this method unlocks possibilities for new applications which can benefit from the enhanced separation and detection offered by UPC2-MS/MS.

### AFRICAN CANCER INSTITUTE (ACI)

The ACI at the SU Faculty of Medicine and Health Sciences serves as a coordinating and directive institution for research and training in the field of cancer dedicated to improving cancer prevention, diagnosis and management in Africa. Prof Vikash Sewram, director of the ACI explains: “Cancer risk identification and prevention, along with advancements in early cancer detection and treatment, are emerging as critical national health issues that need to be addressed appropriately in order to improve the quality of life of South Africans.”

Cancer research funding devoted to prevention/public health efforts have also grown marginally compared to efforts at developing treatments which have produced only modest clinical results. Sewram believes that increased efforts into research on prevention and screening are likely to produce benefits that far outweigh its proportion of investment. “We have treated cancer more so as a medical problem and now we need to approach it as a public health problem. Cancer and its many associated issues indeed have a significant impact on public health,” added Sewram.

## 13

## CLIMATE CHANGE

Researchers warn that the many observed impacts of climate change at different levels of biological organisation point to an increasingly unpredictable future for humans in terms of food security and health. Forecasting these impacts on local and global biodiversity remains one of the biggest challenges among scientists, conservationists and policymakers.

“South Africa’s climate will continue to change in drastic ways into the future. Depending on the region, we may see more frequent extreme events, such as heat waves and droughts, or increased precipitation and temperature variation,” says Dr Susana Clusella-Trullas of the SU Department of Botany and Zoology. She believes the study of climate change ecology is essential to assess the vulnerability of species to climate change and their potential resilience in different parts of the country. Her CL.I.M.E (Climate and Invasions: Mechanisms in Ectotherms) lab explores the evolutionary and ecological mechanisms that animals use to cope with these changes, and will use this information to improve predictions of climate change impacts on biodiversity.

Researchers have also started to look at the consequences of multiple stressors such as biological invasions and climate change and how these drivers may interact and affect fauna in unexpected ways. In terms of climate change ecology, researchers focus on how animals and in particular ectotherms (insects, reptiles) respond to changes and how vulnerable they are now and might be into the future. This is done by combining these animals’ responses to temperature variability, such as behavioural, physiological and morphological trait variation and also by integrating the range of microhabitats that

they may be able to use in their natural landscapes. Inclusion of ecologically relevant microhabitats into assessments of species vulnerability to climate change will provide more realistic estimations of climate change impacts on ectotherms.

Climate change is a problem that bridges the gap between social action and ecological effects, and between society and nature, and is closely related to many areas of environmental, political and economic concern, believes Prof Oliver Ruppel. He is an internationally accredited legal expert on climate change, professor in the Department of Mercantile Law and director of the Development and Rule of Law Programme (DROP) at SU. Ruppel further holds that a hybrid problem like climate change is marked by a high degree of complexity and can only be dealt with if a society’s capacity for taking action is increased and its knowledge base deepened. The challenges that this scenario represents, demand an interdisciplinary approach to research on climate change. At DROP the special emphasis lies on the linkage between law and development, focusing on reconciling the tensions between environmental sustainability, economic growth and human welfare.

Ruppel co-edited the book *Climate Change: International Law and Global Governance* (2013), and the first annual *International Yearbook of Soil Law and Policy* published by Springer (2017). It explores the (legal) implementation of the sustainable development goals in achieving a so-called land degradation-neutral world, countering the impacts of climate change.

## 14

## COMPLEXITY

“We live in an age marked by unprecedented technological innovation, political freedom and scientific discoveries and despite these developments, it seems that our current world is facing even bigger problems than ever before when we consider global climate change, the rise of new and incurable epidemics and the threat of natural resource depletion.” This is according to Dr Rika Preiser, researcher at the complexity and systems modelling research group at the SU Centre for Complex Systems in Transition (CST). “The famous words by Albert Einstein that ‘we cannot solve our problems with the same thinking we used when we created them’, seem appropriate to justify the two decades of research on complexity at Stellenbosch University,” says Preiser.

SU research on complexity has two distinct starting points. The first can be traced back to the Department of Philosophy where Prof Paul Cilliers developed a deeper understanding of the nature of complex systems based on his explorations of contemporary perspectives in philosophy and science. In 1998 he published his book *Complexity & Postmodernism: understanding complex systems* which became a cornerstone publication in the field of complexity studies. Throughout his career, his work contributed to establishing the grounds for understanding complex phenomena from which he drew important theoretical, methodological and ethical implications.

A second starting point is marked by the work of Prof Jannie Hofmeyr who, since the 1980s, studied the inner workings of the cell at the SU Department of Biochemistry by exploring the control and regulation of cellular processes using theoretical, computer modelling and experimental approaches.

He made fundamental contributions to the development of metabolic control analysis and computational cell biology which now forms a basis for understanding the complex processes of cellular metabolic regulation. His interest in exploring whether it is possible to formally model the functional organisation of the cell in terms of a theory of molecular self-fabrication has led him to a broader study of complex systems, not only of biological systems, but also of ecological and sociological systems.

Through their mutual search for understanding complexity from cellular to the societal levels, Hofmeyr and Cilliers established the SU Centre for Studies of Complexity in 2009. This now forms part of the CST, established in January 2016 and endorsed by the National Research Foundation of South Africa to be a nationally leading research centre in the field of environmental and social sustainability. The aims of the CST are to develop a multi-disciplinary research and postgraduate training centre that brings together insights from different disciplines to advance understanding of the interlinked social, economic, institutional, political and ecological dimensions of environmental and social sustainability and to address issues of deeper systemic transformation, specifically in an African context. The CST builds on the strong legacy of research on complexity and sustainability at Stellenbosch University, and provides the institutional framework for experimenting with new emerging forms of knowledge production and collaborative action as a response to the complex challenges facing society.

Led by Hofmeyr, Preiser and Prof Josephine Musango, the research group aims to develop the conceptual principles and modes of inquiry that offer practical heuristics to engage with uncertainty and change by considering the dynamic nature of complex systems. Through this platform the CST also forges continued collaboration with the SU Department of Philosophy where Dr Minka Woermann continues to develop a deeper understanding of philosophical complexity as published in her recent book *Bridging Complexity and Post-Structuralism: insights and implications* (2016).

### THE CENTRE FOR COMPLEX SYSTEMS IN TRANSITION (CST)

The CST brings together complexity thinking, sustainability science and transdisciplinary research methodology. Here research is done by inter- and transdisciplinary teams that also draw in expertise from policy, practice and local stakeholders. Cross-cutting research themes such as governance, entrepreneurship and innovation; social-ecological resilience; decoupling and resource flows; complexity and systems modelling, and transdisciplinarity are applied to research pertaining to food, water, energy and urban systems.

### SA RESEARCH CHAIR IN SOCIAL-ECOLOGICAL SYSTEMS AND RESILIENCE

The Chair, held by Prof Oonsie Biggs and situated in the Centre for Complex Systems in Transition, aims to contribute to addressing theoretical, methodological and empirical gaps in our understanding of social-ecological systems and resilience by employing transdisciplinary methods in ways that integrate approaches from the social and natural sciences, while simultaneously engaging with stakeholders outside academia. It will add to a southern African perspective, and in the process develop an internationally recognised hub of excellence in this field.

There is also a growing concern about the long-lasting effects of head injuries. The risk of repetitive concussion potentially leading to a catastrophic form of brain injury known as a second impact syndrome is thought to be due to the second concussion that occurs in a period of metabolic brain vulnerability. Repeated injuries may cause both immediate concussive symptoms, and could lead to a spectrum of neurological conditions, such as chronic traumatic encephalopathy or dementia.

The diagnosis of concussion currently is based primarily on reporting subjective symptoms. This indicates a major need for objective diagnostic markers of concussion.

The primary aim of a doctoral study by Nadja Snegireva of the SU Department of Sport Science is to evaluate the validity, reliability, and clinical utility of eye tracking as a sports concussion assessment tool by comparing concussed patients to healthy controls and/or by comparing athletes' baseline to their post-impact values up to 12 months. It is believed that studies will show eye-tracking technology as a sensitive, valid and reliable acute and long-term assessment tool for diagnosing sports concussion that is also able to differentiate between adults, adolescents and children as well as between men and women.

Eye movements are controlled by a distributed cortico-cortical network, where each region has strong anatomical connections to the other regions, which explains the high prevalence of oculomotor and attention deficits in concussion. Tracking of these movements has been extensively used in neuroscience and psychology studies, and recently also in concussion research.

A review of the publications has identified several approaches to concussion diagnostics using eye movements. One of them involves assessing fixations (state of the eye when it is relatively still for some time, for example when the eye temporarily stops at a word while reading); or the saccadic eye movements (rapid motions of the eye from one fixation to another). Another approach relies on the ability to accurately follow a moving target (smooth pursuit eye movement) in detecting concussion.

# 15

## CONCUSSION

Concussion is a frequently occurring sports injury that has even been called a silent epidemic. The past decade has seen a growing recognition of consequences of concussion and their severity with the World Health Organization estimating that the concussion rate per year in the general population is over 6 per 1 000 people.

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## DECIDUOUS FRUIT

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The deciduous fruit industry has recently been faced with many challenges of which the most prominent has been climate change and specifically a reduction in available irrigation water. Nevertheless, the pome and stone fruit industries are sound and new plantings have made up for lower yields due to water restrictions. Medium-term projections are therefore very positive and the industry is well positioned to address international market demands.

The deciduous fruit industry comprises 2 252 producers with R13,63 billion per annum turnover of which 44% is generated through exports, produces fruit on ca. 80 000 ha, and provides 1,34 permanent jobs per hectare. The challenges are numerous however, and HORTGRO Science's focus is to keep the South African pome and stone fruit growers internationally competitive and economically sustainable. The emphasis is on research and development, generating new knowledge, technologies or practices that are required to mitigate, avoid or overcome threats and risks as well as to exploit opportunities. HORTGRO Science pursues these aims through research partnerships with amongst others Stellenbosch University. Human capacity development and the creation of the next generation of researchers remains a key focus of the long-term research programme. They are currently funding 49 SU postgraduate students.

### HORTGRO CHAIR IN APPLIED PRE-HARVEST DECIDUOUS FRUIT RESEARCH

The HORTGRO Chair held by Prof Karen Theron and based in the Department of Horticultural Sciences, focuses on research to meet the short- and long-term

needs of fruit producers, with the purpose of improving international market access, fruit quality and sustainable farming practices. It also enhances the valuable liaison between the academic world and the industry. Another focus of the Chair is to develop human capacity, both at an undergraduate level as well as at the applied, technical postgraduate level.

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## DEMOCRACY

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“Research on democracy is vital. It not only informs us of what a democracy should be, but it allows for a reality check on the performance of a democratic government and how this performance is assessed by the citizens,” believes Prof Ursula van Beek of the SU Department of Political Science. “At SU we have enriched the study of democracy by pioneering a comparative approach that combines empirical research with in-depth case studies of a number of new and old democracies around the globe. In this way the quality of democracy can be examined across different cultural regions,” says Van Beek.

The prospects for democracy in South Africa came under the watch of an international group of researchers led by Van Beek even before the first democratic election of 1994 took place. Nearly a quarter of a century later the much enlarged research team continues to study democracy, but now as the Transformation Research Unit (TRU) established at the SU Department of Political Science. Since the modest beginnings, several research projects have examined South Africa's democracy in comparison to countries worldwide such as the younger democracies of Chile, Poland, South Korea and Turkey, as well as the well-established democracies of

Germany and Sweden, which serve as control cases.

The establishment of TRU: Southern Africa in November 2015, brought on board researchers from Namibia, Botswana and Zimbabwe, putting South Africa's democracy under review also in a comparative regional context. In May 2018, TRU is launching an open access Data Centre for the study of democracy and an associated training programme in mixed research methods for young researchers. The Data Centre will integrate South African research on democracy into global data networks.

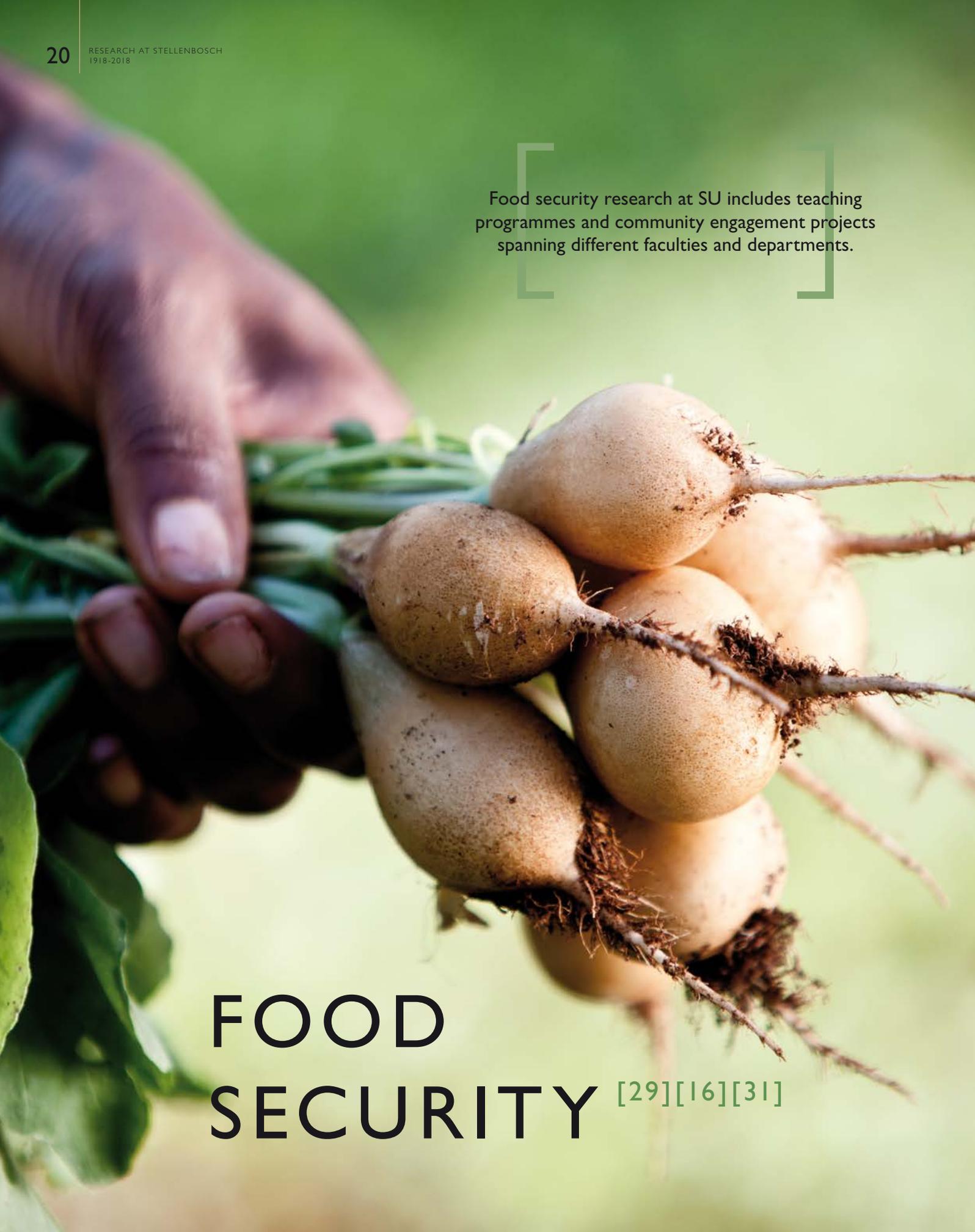
TRU's outputs include a series of books of which the latest volume, entitled *Democracy under Threat: A Crisis of Legitimacy?* (in press), addresses some of the most burning questions of our time: how does globalisation affect democratic nation-states?; does the screen culture of television and the internet impact democracy?; what are the implications for democracy of the more fragmented world where the urge to identify the 'enemy' has once again surfaced highlighting contrasts between ethnic, cultural and religious values and giving rise to fundamentalism and a nationalist brand of populism? And the most important question of all: is the legitimacy of democracy in the world in crisis?

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## DIABETES

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Diabetes continues to affect millions of people globally despite substantial efforts to implement therapeutic measures. One way of reducing the alarming levels, especially in developing countries like South Africa, is to prevent the early onset of insulin resistance and to gain new information about its underlying cause, says Dr Danzil Joseph of the SU Department of Physiological Sciences.



Food security research at SU includes teaching programmes and community engagement projects spanning different faculties and departments.

# FOOD SECURITY [29][16][31]

Joseph's doctoral study produced data on insulin resistance that could help prevent the early onset of insulin resistance. Chronic high blood sugar, a hallmark of diabetes, is linked to insulin resistance in heart cells and may be prevalent in the early stages of diabetes or as a result of high sugar intake coupled with physical inactivity. Results of his study showed that acute high blood sugar elicits harmful reactive molecules which, together with a number of lesser-known pathways involved in glucose metabolism, play a role in reducing glucose uptake in heart cells.

Joseph believes that this may have a significant impact on the progression of heart disease – a major cause of death and disability among individuals with diabetes. Findings from this research could help with the development of affordable and effective medicine, especially since current treatment and management of diabetes are difficult and expensive, resulting in an economic and social burden on healthcare systems.

According to Prof Bob Mash of the SU Division of Family Medicine and Primary Care, health centres are overwhelmed with thousands of patients suffering from diabetes and struggle to provide effective education and to support lifestyle modification. This division has been a founding member of the research network, Chronic Disease Initiative for Africa, and has a particular interest in research on type 2 diabetes.

Researchers tested a newly developed approach to group diabetes education in Cape Town's health centres through a pragmatic, clustered, randomised, controlled trial. The approach to group diabetes education included four sessions for patients on understanding diabetes; lifestyle change; understanding medication and avoiding complications; and combined relevant content presented in a style that elicited a change in behaviour. The trial showed that this was a cost-effective intervention in this setting, even when education was offered by a non-professional health worker. Following the trial, the Metropolitan District Health Services decided to integrate group diabetes education into routine care at the health centres. The roll-out is currently being coordinated by the family physician's forum.

"Although health centres in Cape Town are well resourced in terms of medication and equipment, only about 30% of patients achieve good control of their blood glucose," says Mash. One of the difficulties has been that the result of the laboratory test to determine control of diabetes is not immediately available. "Decisions regarding control that were made on random blood glucose testing, which is immediately available, were shown to be wrong in up to 25% of cases," explains Mash. Further research was therefore done at four health centres on point-of-care testing, where the laboratory test was performed on site and made available immediately. "Unfortunately, in our primary care context making this test result immediately available did not lead to improved clinical care," Mash said. "A further study is now underway to investigate if a more intensive approach to diabetes management combined with point-of-care testing will make a difference."

Many patients with diabetes develop complications such as kidney disease, cataracts and damage to the retina at the back of the eye, with renal failure and blindness as possible consequences. These complications are meant to be screened for on an annual basis. Currently about 80% of patients are annually tested for proteinuria (macro-albuminuria), a sign of kidney disease, and about 30% of patients test positive. This test, however, detects established kidney disease, which is difficult to reverse. Most guidelines recommend testing for micro-albuminuria when kidney damage may still be reversible or preventable. Research demonstrated that performing point-of-care testing for micro-albuminuria in the primary care setting was feasible, relatively cheap, and led to useful interventions to prevent kidney disease.

Currently around 33% of patients receive the annual screening for eye complications in Cape Town's health centres. One of the difficulties is that examination of the retina requires the placement of drops in the eye to dilate the pupil and skilful use of an ophthalmoscope by the nurse or doctor to assess the retina. Research demonstrated that a fundal camera,

operated by a community health worker and without the need for any drops, could more effectively screen patients and was cost-effective. Of those photographed 27% needed referral for cataract, 7% for retinopathy (63% had a degree of retinopathy) and 4% were referred for other reasons. The Metropolitan District Health Services have subsequently adopted retinal screening by fundal camera as policy. Coverage is currently limited by the capacity of the specialist services to treat those that are referred.

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## DISEASE

South Africa has the sad distinction of being a country with an estimated 7,1 million HIV-infected inhabitants – the highest in the world. Fortunately, it has also become the country with the highest number of patients on antiretroviral therapy (now estimated at almost 4 million). Whilst this is a remarkable achievement, many challenges remain: from ensuring long-term treatment success and avoiding the emergence of antiretroviral drug resistance, to addressing opportunistic infections and understanding immune phenomena.

The International Research Training Group (IRTG): HIV/Aids and associated infectious diseases in southern Africa, was a partnership between Stellenbosch University, the University of Cape Town and the University of Würzburg in Bavaria, Germany. IRTGs are coordinated postgraduate training programmes in which doctoral students and their supervisors work together on thematically linked research projects. Launched in 2009, the IRTG was coordinated by Prof Wolfgang Preiser, of the SU Division of Medical Virology and Prof Axel Rethwilm, then Head of the Institute for Virology in Würzburg.

The aim of the participating research groups was to link clinical and basic research so that one could benefit from the other, ultimately generating knowledge necessary to improve the management of HIV infection. Topics included the molecular diversity of HIV, antiretroviral drug resistance, therapeutic drug monitoring, mechanisms of virus-induced immunosuppression, novel therapeutic compounds, *Staphylococcus aureus*, and various aspects of the immunology of infectious diseases.

This was the first-ever IRTG with Africa partners, comprising 12 research groups at the two South African universities and their 12 collaborating partners at Würzburg University. The South African groups were funded by the National Research Foundation and their Würzburg counterparts by the German Research Foundation, DFG.

The students were supervised by established scientists. An exchange programme with the Würzburg partner laboratories and an elaborate postgraduate education programme were central, in order to offer innovative postgraduate training of a high standard, exposing students to world-class research groups and equipping them with skills and knowledge that will allow them to become excellent researchers themselves.

The IRTG took great care to avoid a scenario known as 'helicopter science', whereby patient samples would be obtained in Africa but almost all scientific analysis takes place in developed countries. On the contrary, all analyses took place locally as far as possible, and when certain advanced tests were not yet available here, the doctoral candidate joined work undertaken in Würzburg with a view to establishing the method in South Africa. This way South African researchers gained access to technologies not yet available at home. At the same time, scientists in Würzburg got the opportunity to investigate conditions rarely seen in Europe.

While the IRTG partners were under no illusion that they would be able to solve the HIV problem in the foreseeable future, they endeavoured to provide optimal training for the young scientists that will hopefully one day be able to contribute

to this goal. Among the very positive experiences was the flexibility of the NRF that, even in the absence of a formal call, allowed the IRTG to take shape.

Unfortunately though, Africa's first IRTG failed to pass its mid-term evaluation. The review panel consisted of German scientists only and some of its members were highly critical of the perceived lack of progress of many of the African PhD candidates and some other aspects of the project. The IRTG was thus not extended and came to an end. To date (March 2018) it remains the only IRTG between a German and any African university.

Despite not being continued, the IRTG has been a success: All students graduated; there have been numerous scientific publications stemming from it, and a number of collaborative grants were obtained subsequently by IRTG partners. One of the former IRTG PhD candidates, Dr Justin Nono Komgwe, was awarded the prestigious Sydney Brenner Fellowship by the Academy of Science of South Africa in 2015.

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## DRAMA

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"It is intrinsic to human nature to seek acknowledgement of self, and empathy with others, by embodying character and action," says Dr Samantha Prigge-Pienaar, an awarded artist and senior lecturer at the SU Department of Drama.

According to Prigge-Pienaar the SU Department of Drama promotes such self-reflection and collaboration, and invites learners to understand the particular part they play in a complex global environment. This is done through its current focus on a range of skills – including vocal dynamics, group exploration, improvisation, creative writing, multi-media and play.

Prigge-Pienaar contends that it is these skills that enable former drama students to become critical citizens, contributing to social development and social cohesion through a diverse range of jobs. In today's fast-changing global consumer culture many of these skills, including adaptability, collaboration, communication, innovation and creativity, are considered vital and are sought after by emerging entrepreneurs and established corporations alike.

A skill that is prominent in drama education and training, but often given little recognition, is empathy – or the ability to walk in someone else's shoes. "In a culture such as ours where inclusivity through diversity is a recurring theme, the ability to feel how others might feel in a situation should be considered essential for social cohesion," says Prigge-Pienaar.

The Department often uses arts-based methodologies for the creation of socially-relevant productions. For example, *Ontwrig* (2015) formed part of a bilateral research project that investigated trauma in a post-apartheid South Africa. In this production, Prof Petrus du Preez and Estelle Olivier investigate identity, trauma and history using physical theatre, dance, puppetry and stop-motion animation and text. The cast of students were all so-called free-borns and the production offered them the opportunity to express and embody their feelings, views and experiences about the socio-political situation on campus, as well as in the country.

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## DROUGHT

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Water – or the lack thereof – as a topic of conversation has moved from university classrooms and laboratories to the households of the entire population.



### SMART METERING TO SAVE WATER

Saving water and money at schools has been the focus of a project by Prof Thinus Booysen and his team from the SU Department of Electrical and Electronic Engineering. Through the use of smart-metering technology they have enabled schools and households to limit water usage and minimise expenses. The novel smart water meter, Dropula, is intended to change water-use behaviour. Following on the success of the testing of a prototype, the #SmartWaterMeterChallenge was launched in partnership with Shoprite, Cape Talk, Bridgiot, Pragma and the Western Cape Education Department in November 2017. It involved means by which corporates could sponsor a school to receive two stages of intervention, namely a plumbing maintenance stage, followed by a behavioural change intervention. In total 93 corporates sponsored 358 schools. To date, 210 schools have been equipped with the Dropula, resulting in the saving of 40 million litres of water. The behavioural intervention, in collaboration with UCT's School of Economics and the Department of the Premier, will commence in 2018.

The awareness created by the present drought conditions is at least one positive point amidst the sacrifices, losses and health risks that the whole population in the drought-stricken areas face daily. Dr Jo Barnes of the Department of Global Health, Health Systems and Public Health believes that we should not let a 'good drought go to waste' and rather remember lessons learnt and ways found to adapt to the crisis. She maintains that the large and diverse expertise present at Stellenbosch University can make a significant difference between a haphazard approach to drought mitigation and a professional response that can minimise the impact and help us manage better in the future.

"One of the complex reasons for the current impasse is that water delivery is multifaceted, needing the cooperation of many stakeholders in local, provincial and central government departments," Barnes says. One common contention is that we are facing a very severe drought (the number of years it was last this dry is under dispute) and nobody could have foreseen that. But, says Barnes, professional disaster management does not depend on when and how bad the next crisis is expected to be. "Forecasting probabilities has nothing to do with disaster preparedness, but everything to do with the crucial importance of the systems what may be affected. If one cannot do without water then preparing for the next drought starts immediately, regardless of when the next drought is expected to happen. Waiting for the tell-tale signs of drought before starting mitigation measures, is called gambling and not disaster preparedness."

One consequence of the lack of preparation is the worrying change in attitude regarding the essential elements of planning for the protection of people's safety and of the environment. Drilling boreholes into sensitive aquifers, extracting large amounts of water from aquifers close to the sea with the resultant danger of intrusion of seawater, erecting desalination plants that are not fit for purpose or poorly sited are all costly consequences of this change in attitude that is driven by alarm. "In addition, education campaigns to use

greywater safely are lacking and are now too late as many persons have started their own systems or ways of using greywater," argues Barnes. "While there are SU studies underway to look at such reuse, much more research is needed into fail-safe systems and actual health risks under local conditions."

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## DRUGS

Glucocorticoids (GCs) are drugs used to treat inflammatory disorders such as asthma and arthritis. They mediate their effects through an intracellular steroid hormone receptor, the glucocorticoid receptor (GR), which is a ligand-activated transcription factor that can, by binding to DNA, control the expression of a host of genes – including genes involved in suppressing inflammation. While amongst the most potent and efficacious anti-inflammatory drugs, GCs can cause severe side effects such as metabolic disease and glucocorticoid-induced osteoporosis when used at high dosages for long periods. Furthermore, acquired glucocorticoid (GC) resistance is becoming a major concern – approximately 30% of all patients receiving treatment experience a degree of GC insensitivity.

Thus, the search for improved drugs, which display fewer side effects and are less likely to elicit resistance, is of enormous medical and social interest. The development of so-called dissociating glucocorticoids is a particularly promising concept. It is based on the hypothesis that selectively preventing ligand-induced DNA-binding and/or dimerization of the GR (an integral step in GC signalling, which current GC drugs elicit) might be the key to reducing unwanted side-effects while retaining therapeutic

### ANTIBIOTICS FROM FYNBOS

As the health industry is facing an uphill battle against disease, and with very few new antibiotics making it through the discovery pipeline, it is imperative that alternatives to traditional antibiotics are found as soon as possible, says Dr Du Preez van Staden, a postdoctoral research fellow from the Department of Physiological Sciences. In search for antimicrobial-producing bacteria, Van Staden dug through bacteria-rich fynbos soils. He focused on a group of peptide antibiotics, known as lantibiotics, which have a similar mode of action to that of a potent antibiotic, vancomycin, used to treat a number of bacterial infections. After having isolated the two lantibiotic-producing bacteria from fynbos soil, Van Staden tested their potential to inhibit the growth of pathogenic bacteria. "Results showed that the bacteria from fynbos soils produced lantibiotics that are active against a range of bacteria, including methicillin-resistant *S. aureus*." He believes that lantibiotics also have the potential to help fight bacteria that cause abdominal infections, infections of medical implants and soft tissue, bacterial gastroenteritis, as well as inflammation associated with these infections.

efficacy. Researchers in Prof Ann Louw's laboratory in the SU Department of Biochemistry are investigating the implications of dimerization of the glucocorticoid receptor in GC signalling. It is part of long-term research on Compound A (CpdA), an analogue of the active component in the indigenous shrub gannabos (*Salsola tuberculatiformis* Botsch). This novel compound was synthesised by SU biochemists.

Initial work on fractionation of the shrub and on identifying the active component was done by Proff Kirsten van der Merwe, Pieter Swart and Amanda Swart. Louw has continued the work with the more stable analogue, CpdA. CpdA was shown by the Louw group to abrogate GR dimerization, which correlates with its dissociated behaviour by suppressing inflammation without eliciting negative side-effects. Ligand-independent dimerization of the GR can occur at high GR levels – thus priming the system for response and increasing the potency of GR agonists. A crucial step in determining GR function is nuclear translocation of the GR as this transcription factor mediates its effects via interaction with DNA and when GR dimerization is compromised by using CpdA, nuclear retention of the GR is decreased. Recently, the group discovered that loss of GR dimerization can limit ligand-induced down regulation of the GR, a major factor in GC resistance, thus suggesting that targeting GR dimerization to prevent resistance may be a fruitful avenue to explore.

Louw believes that this line of research not only contributes to identifying potential novel leads for drug discovery, but also has the ability to shift the current thinking of long-held paradigms concerning steroid hormone receptor signalling in new directions, not previously anticipated.

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## DYSLEXIA

People with dyslexia struggle to find jobs in the legal industry because employers draft advertisements in a way that excludes them. This is one of the key findings of a study by Monja Posthumus-Meyjes, an attorney at SU's Law Clinic, who recently obtained her master's degree in law.

"People with dyslexia are routinely discriminated against as the wording in advertisements greatly impair or nullify their chances to obtain positions and indirectly exclude them from being considered for jobs," contends Posthumus-Meyjes.

Her study addressed the exclusion of people with dyslexia who apply for jobs in the legal industry, and also evaluated whether such direct or indirect discrimination can be justified as an inherent job requirement and/or unjustifiable hardship to reasonably accommodate persons with dyslexia. She analysed advertisements by some legal organisations in South Africa and also examined court cases that focused on whether inherent requirements of a job can be seen as a form of indirect discrimination.

As a person with dyslexia who had to overcome great challenges pertaining to writing, reading and finding employment, Posthumus-Meyjes found that the wording in advertisements amount to indirect discrimination on the basis of disabilities and that indirect discrimination was not rational, fair or justifiable. "If people with dyslexia apply for a position which requires 'excellent reading and writing skills', they would in all likelihood not be invited for an interview, solely on the basis of their disability."

According to Posthumus-Meyjes, employers are ignorant about people with disabilities and use certain policies,



SU researchers believe that climate change is a problem that bridges the gap between society and nature, and is closely related to many areas of environmental, political and economic concern.

# CLIMATE CHANGE <sup>[13]</sup><sup>[22]</sup>

### THE BIOLOGY OF MEDITERRANEAN-TYPE ECOSYSTEMS

In the book, *The Biology of Mediterranean-Type Ecosystems*, Prof Karen Esler of the SU Department of Conservation Ecology and Entomology, and co-authors Anna L Jacobsen and R Brandon Pratt provide a concise but comprehensive introduction to Mediterranean-type ecosystems with an emphasis on the organisms that dominate these regions. Their management, conservation, and restoration are also considered. The world's Mediterranean-type climate regions (including areas within the Mediterranean, South Africa, Australia, California and Chile) have long been of interest to biologists by virtue of their extraordinary biodiversity and the appearance of evolutionary convergence between these disparate regions. Comparisons between Mediterranean-type climate regions have provided important insights into questions at the cutting edge of ecological, ecophysiological, and evolutionary research. These regions, dominated by evergreen shrubland communities, contain many rare and endemic species. Their mild climate makes them appealing places to live and visit and this has resulted in numerous threats to the species and communities that occupy them. Threats include a wide range of factors such as habitat loss due to development and agriculture, disturbance, invasive species and climate change.

procedures, inherent job requirements as well as unjustifiable hardship as a justification for not appointing them.

"While it can be argued that the ability to read and write is an essential part of being an attorney, exceptional reading and writing skills cannot be argued to be an inherent requirement of the job, as it is an undefined and subjective criteria."

Posthumus-Meyjes says it has become a trend to draft advertisements in such a way as to benefit employers and to vindicate them from having to appoint persons with disabilities and/or to reasonably accommodate them. She adds that this trend continues despite the fact that the Constitution and the Employment Equity Act protect persons with disabilities against discrimination. "The only focus of the employer should be whether the applicant has the necessary qualifications, and then consider but for the disability, would this person with reasonable accommodation be able to perform the work."

Posthumus-Meyjes believes that people with dyslexia, depending on their level of reading difficulty, can be accommodated by using dictation which is then transcribed by a secretary, or if they are required to do their own writing, special dyslexia fonts, special keyboards, or even computer software can assist them with the writing process.

demands of a growing human population that is consuming natural capital far more rapidly than our ecosystems can sustain.

Multidisciplinary research which includes studies by SU economists, ecologists and hydrologists of the biophysical and socioeconomic dimensions of a range of existing restoration initiatives in South Africa contributes to the evidence-base in support of ecological restoration as a way to build resilience into our social-ecological systems.

It refers specifically to the assessment of restoration on the ecology, hydrology and economy of agricultural lands, building a business case for clearing invasive plants in the key water source areas of the Western Cape water supply system, and the restoration of degraded wetlands in terms of its potential to supply clean water. "As Cape Town (and the region) face the consequences of the worst drought in recorded history, this work is elevated in significance," believes Prof Karen Esler of the SU Department of Conservation Ecology and Entomology.

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## EDUCATION

In many ways, the book *Educational leadership in becoming: On the potential of leadership in action* (2017) by Prof Nuraan Davids and Prof Yusef Waghid from the SU Department of Education Policy Studies, grew out of a discontent with the university and school sectors in South African education succumbing to the neo-liberalist inspired marketisation of education. Such a view considers universities and schools as sources of profit, and students as consumers of 'commodified' knowledge who should be trained and socialised as technicians of learning to fit into the market-driven work culture. The authors contend that

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## ECOLOGICAL RESTORATION

Functional ecosystems provide us with a wide range of goods and services that are essential for human well-being. But our ecosystems are under pressure from the

the majority of educational leaders in this neoliberal climate of education-for-profit have been complicit in reaffirming the private consumerist interests of corporate power as evident from the crises that currently plague university and school education.

The main concern raised is with the ethical realm of education and educational leadership. Current policy on educational leadership remains fixated on measurable, pre-determined outcomes, with scant attention paid to the dire need for ethical practices. The authors argue that if educational leadership were to be inspired by the concern for public responsibility and social justice, it will not only allow educational discourses to venture into the realm of respect for others and difference, critical imagination and deliberative engagement, but also stimulate educational leaders to take more responsibility for their actions and to rethink their educational offerings with a deep concern for social justice.

In *Tolerance and Dissent within Education: On cultivating Debate and Understanding* (2017), Davids and Waghid consider how the concept of tolerance might be understood, cultivated and enacted in and through educational encounters.

They contend that the exercise of tolerance can be seen as an acknowledgement of difference, and as such, disagreement; and has as much to do with seeing the value of another's truth as it has to do with acknowledging one's own weaknesses and limitations. Davids and Waghid argue that treating one another as moral equals in an atmosphere of tolerance does not imply that people should just do what they want. The act of tolerance is limited to the recognition of people's competing conceptions of the good life for as long as such conceptions do not result in doing harm to others.

An earlier book by the same authors, *Citizenship education and violence in schools: On disrupted potentialities and becoming* (2013), resulted from research on addressing school-based violence through innovative teaching of democratic citizenship education. Against the backdrop of growing calls for harsher measures against learners found guilty

of violence, and in recognition of the growing trend that public schools in South Africa have become associated with stabbings, shootings, rapes, assault, humiliation and discrimination, the book offers an unexplored glance at what could be described as the other side of violence.

Despite many national and provincial government initiatives to keep learners safe, school violence has worsened – in frequency and intensity – to the extent that children are more likely to experience violence at schools than in their homes. Given the complexity and unpredictability of violence, the authors contend that traditional punitive measures are not only inadequate, but inadvertently serve to further fuel the anger and violence.

The authors offer a citizenship education-of-becoming as a response to the unpredictable consequences of violence. They argue that schools should create the necessary spaces for dialogue; to engage with the learner from his/her own perspective; and to enact the language and behaviour that are desired from learners. By consciously setting out to reach out to the humanity of the learner, learners are not dehumanised in a way that could happen when they are rebuked, humiliated or pushed away.

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### ENERGY USE

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Researchers of the SU Department of Electrical and Electronic Engineering created a smartphone application, Geasy, to allow consumers to remotely monitor and control their electrical water heaters (EHW) and water meters from their mobile devices. This comes in the midst of one of the worst drought periods in the country and uncertainty at the national energy utility, Eskom. Prof Thinus Booysen of the Department believes that in an era

of increased water shortages and higher electricity prices, technology such as the Geasy could help households save money, save water and use less electricity.

The feedback system consists of several components: an android mobile application; an event detection algorithm, and the world's first mathematical model measuring the electricity consumption of horizontally-installed geysers. This had to be done because most geysers in South Africa are installed lying flat on a ceiling, whereas the worldwide norm is space saving vertically installed ones.

It conveys real-time data on electricity and water use to a user-friendly app. The system can also control the inflow of water in case it needs to be switched off when a pipe bursts or a geyser overflows. It also informs users on the energy and financial savings achieved by switching their EWH off intermittently or by changing its set temperature. Additionally, the event detection algorithm is used to establish usage patterns and to provide recommended control schedules for users.

Through funding from the Water Research Commission, the full system is being tested in the Mkhondo municipality in Mpumalanga, as well as in 50 private homes in the Western Cape and beyond. Data gathered by each device is constantly sent back to the SU lab for further analysis. The Geasy has since evolved into the Dropula water meter through the spin-off company Brigdiot and SU's technology transfer company Innovus.

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### EPIDEMIOLOGY

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A multidisciplinary team of scientists developed SIMFACT, a modelling platform that can simulate the spread of HIV and estimate the impact and cost-effectiveness of prevention and

treatment interventions. This is just one example of the work done by the South African Centre for Epidemiological Modelling and Analysis (SACEMA) at Stellenbosch University.

The SIMPACT team is a dynamic group of researchers with academic affiliations at SACEMA, the Centre for Statistics at Hasselt University, the International Centre for Reproductive Health at Ghent University, and the Vaccine and Infectious Disease Institute at the University of Antwerp. While hundreds of purpose-specific models for HIV transmission, prevention and treatment have been developed over the past 25 years, SIMPACT avoids the need to build ad-hoc models from scratch every time researchers and decision-makers want to address a new research or policy question.

Prof Wim Delva, an epidemiologist at SACEMA and one of the team members, explains: "SIMPACT is an individual-based model for HIV transmission, prevention and treatment in a sexual network. Such a model can keep track of the history of events of individuals, making it possible to see exactly how many times an HIV-infected individual transmitted the virus by the end of his or her life; who became orphaned due to Aids-related death of his or her parents and at what age; or how many lifetime sexual partners the average 35-year old man has had."

In SIMPACT, the complexity of HIV transmission and any prevention and treatment interventions that may be simulated is easily adjusted. Delva clarifies: "In addition to defining the composition of the population in which the epidemic will take place, we can specify which events are possible. By default, possible events include HIV transmission, relationship formation and dissolution, antenatal care, pregnancy and birth, Aids- and non-Aids-related mortality, male circumcision, condom use, antiretroviral treatment initiation, and HIV counselling and testing."

After the simulations are run, the data is interpreted using health economic and network analyses. According to Delva, SIMPACT allows researchers to combine several disciplines in the quest for effective and affordable measures to curb the

ongoing burden of HIV and Aids. SIMPACT team members believe that in the quest for effective and efficient HIV treatment and prevention programmes in countries with generalised and concentrated HIV epidemics, they can make a tangible contribution to evidence-based decision making in HIV-related public health policy and programme implementation.

#### **SOUTH AFRICAN CENTRE FOR EPIDEMIOLOGICAL MODELLING AND ANALYSIS (SACEMA)**

SACEMA, led by Prof Juliet Pulliam, specialises in model-based analysis to improve health in South Africa and across the continent. Trained as mathematicians, biologists, physicists, economists, statisticians, and epidemiologists, SACEMA's researchers bridge disciplines to understand disease dynamics and improve real-world outcomes. Developing and analysing models allow researchers to study patterns of disease progression, in space and time and at population and within-host levels. These models are then used to assess the likely outcomes of various interventions and to provide a sound scientific basis for health policy. The Centre builds local and international capacity in epidemiological modelling and analysis by training postgraduate researchers to work across disciplines and across borders, generating meaningful models of real data related to pressing human needs.

#### **SA RESEARCH CHAIR IN MECHANISTIC MODELLING OF HEALTH AND EPIDEMIOLOGY**

The focus of this Chair, led by Prof Jacky Snoep and linked to SACEMA, is to provide a mechanistic modelling approach with more predictive strength to pharmaceutical drug and intervention steps for individual and public health. As a service component for the SARChI project, a curated model database of published mathematical models is available for on-line simulations in a web browser via the JWVS Online servers (in Stellenbosch <https://jij.biochem.sun.ac.za> in Manchester <http://jij.man.ac.uk> and in Amsterdam <https://jij.bio.vu.nl>). The project is linked to several international journals, and data management projects.

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## **FAITH**

"Faith communities exercise a prominent influence in the South African society and worldwide through the ethical values that they promote. These values and their participation in civil society debates are determined by their reliance on and orientation toward scriptures which they consider authoritative," says Prof Louis Jonker of the SU Department of Old and New Testament.

He however argues that when these scriptures (whether the Bible, the Koran or others) are taken on face value, their influence can become dangerous, and scriptures can be abused to serve ideological and political positions. "It is therefore necessary that these scriptures be studied scientifically, particularly by investigating the historical circumstances in which they originated and the historical discourses in which they took part. Only by studying the historical contexts of these scriptures can one avoid their abuse in modern-day debates," believes Jonker.

Jonker argues that the formation of new identities takes place when faith communities retain continuity with their ancient faith traditions, but simultaneously have the courage to reinterpret these traditions in new, changing circumstances. "This observation holds important lessons for modern faith communities regarding their interpretation of the Bible in contemporary contexts," says Jonker.

As a member of the Old and New Testament discipline group and author of a commentary published in 2013 on the biblical book of Chronicles, *1&2 Chronicles*, as well as a monograph published in 2016 on the identity negotiation processes in ancient Israel during the Persian period, Jonker contends that the book of Chronicles in the Old Testament is the result of the

rewriting of the history of ancient Israel (although another history already existed in the books Samuel and Kings) in the light of the new socio-political and socio-religious conditions. The creative re-interpretation of the history in Chronicles reflects the intense processes of the formation of new identities which were required by international events and the influence of the ancient Persian Empire.

He studied the Biblical literature, and the world and history of the ancient Persian Empire to obtain a better comprehension of the influence of this imperial environment on Judah and Jerusalem, as well as of Judah's interaction with its neighbours and the factionalism in the temple in Jerusalem. Cyrus the Great of Persia's conquest of Babylon in 539 B.C. saw the dawn of a new era of political and economic control over the former Babylonian districts and provinces, in which nations were allowed to return from exile. Subjects were allowed a great amount of autonomy and religious freedom, even to rebuild the temple in Jerusalem and to re-organise the cult and priesthood.

This attitude of the Persians had a direct impact on how the subject nations understood themselves. Many residents of Jerusalem in the province Judah, for example, defined and positioned themselves in a society in which the former landmarks of their political and religious identity no longer existed. "They also had to theologially reinterpret the events of their time by asking what 'nation of God' meant during such a period of transition," says Jonker.

"The interesting thing is that these returned exiles to Jerusalem began to dust off their historic traditions and re-interpret them," he explains. "The dynamics of reinterpretation under new socio-political and socio-religious conditions was central to the ancient faith communities, to bridge the gap between the past and the present, with a vision towards the future."

# 29

## FOOD SECURITY

Food security is a global issue and widespread food insecurity and hunger persist in South Africa's urban and rural areas. The current drought and water shortages in the Western Cape are likely to further impact on food and nutrition security, particularly affecting vulnerable communities. While the country is food secure at a national level in terms of aggregate food availability, research suggests that one in two households is at risk of hunger; 16% of people consume less than adequate amounts of energy; and about 20% of children under nine years of age are stunted.

SU has created a platform on which a range of research projects in terms of food security have been developed, including teaching programmes and community engagement projects spanning different faculties and departments.

"All people in South Africa have a constitutional right to be food secure, yet we see such disparity and inequality, and the indicators show an alarming rate of stunting as the triple burden of malnutrition continues," says Julia Harper, SU Food Security Initiative Manager of the Faculty of AgriSciences and Faculty of Health and Medicine Sciences. She believes that it is imperative that research is undertaken to understand the underlying causes of this disparity. "Our research across the food system aims to transform policy and practices, giving communities access to the smallholder farming market, reducing stunting and creating an understanding of farming for the future."

Led by Prof Xikombiso Mbhenyane from the Division of Human Nutrition in the Faculty of Medicine and Health Sciences and Prof Gunnar Sigge from the Department of Food Science, SU's master's programme in food and security

focuses on public health and nutrition and combines rigorous interdisciplinary research and engagement in order to find the most effective approaches to teaching, research policy linkages and social learning. The programme is multifaceted, comprising degree programmes and research projects with food and nutrition security as a theme. The overall objective is to develop the capacity of students to think, analyse and act in an evidence-based way, to deal with complex problems, to reflect on their own thinking and work, and to translate that reflection into the development of more suitable solutions; to develop the capacity to communicate research challenges as well as opportunities and solutions to colleagues and non-specialists; to assist in project/programme management and implementation; and to gain the capacity to form a judgement in an uncertain context.

# 30

## FORGIVENESS

Is forgiveness between black and white South Africans really possible more than two decades after the 1994 transition to democratic rule? This question is central to a body of research on forgiveness, and the so-called politics of forgiveness that is being conducted at Stellenbosch University.

Dr Dion Forster, Chair of the Department of Systematic Theology and Ecclesiology, and Director of the Beyers Naudé Centre for Public Theology, is working extensively on this topic. The research of his colleagues, Prof Christo Thesnaar and Dr Wilhelm Verwoerd also focus on forgiveness and reconciliation. They have been

# RENEWABLE ENERGY [69][79]

At SU, research is not limited to the technical aspects of renewable energy – several departments and research centres contribute to non-technical renewable energy research, ranging from finance to policy to sustainability.



working with Prof Pumla Gobodo-Madikizela, Chair of Historical Trauma and Transformation at Stellenbosch University, whose work engages the question of the various expressions of transformation in post-apartheid South Africa, and what transformation means in the aftermath of a violent and oppressive past.

Forster recently published a book entitled *The (im)possibility of forgiveness?* that records his engagement with black and white Christians in South Africa on their understandings of the notions and processes of forgiveness. This study showed that forgiveness remains a deeply contested and complex issue. According to Forster, these two groups hold very different views on forgiveness; black people understand forgiveness in a collective and social manner, and forgiveness is seen not only as an individual concern but it has social consequences and social expectations. "It is not only as a matter of spiritual restoration between the individual (or community) and God, but also requires the restoration of relationships and structures in the community," says Forster.

Forgiveness in South Africa would be dependent upon economic transformation, transfer of land ownership, a transformation of social power dynamics, and visible and tangible expressions of remorse on the part of the beneficiaries and initiators of apartheid in South Africa.

"Black people don't want cheap forgiveness," says Forster. His research has shown, that in contrast to black South Africans, whites tended to individualise and spiritualise forgiveness. "For them the offended party wasn't the neighbour but God." Forgiveness is enacted when God has set them free from the guilt and spiritual accountability of their actions, it would not necessarily entail the restoration of relational harmony among members of the community or the restitution of social, political or economic structures.

Forster argues that these different understandings of forgiveness contribute towards our inability to work together for transformation, justice and the common good.

The research also shows that these unreconciled persons seldom have positive contact with each other because the legacy of the apartheid system continues to separate persons racially, according to economic class and geographically.

Forster said that despite the significant challenges we face with regards to dealing with the 'sins' of our past and the current complexities, the journey toward shared understandings of forgiveness is crucial for our future. "Under certain conditions forgiveness may be a possibility and the process of rediscovering and appreciating our shared humanity is central to working towards forgiveness in South Africa."

#### RESEARCH CHAIR IN STUDIES IN TRANSFORMATION AND HISTORICAL TRAUMA

Taking an interdisciplinary approach, this Chair, led by Prof Pumla Gobodo-Madikizela, brings a critical research perspective to the traditional approaches to trauma and its trans-generational repercussions, while seeking to engage with the question of the various expressions of transformation in post-apartheid South Africa, and what transformation means in the aftermath of a violent and oppressive past.

Researchers intend to go beyond theoretical debate to engage with questions that have rarely been explored in order to produce knowledge that will inform public opinion. Gobodo-Madikizela asks, for instance, how individuals and communities can deal with violent pasts in a way that restores dignity to victims and enables perpetrators to be accountable for their crimes? Her work focuses on how, in the aftermath of historical trauma, dehumanising experiences continues to impact the next generation, and how the terms reparative humanism as an alternative to the notions of healing and closure function within the relationship between remorse and forgiveness after historical trauma.

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## FUNGUS

Containing the outbreak of a devastating plant disease on two Cavendish banana export farms in Mozambique is not only about saving the companies involved; it could ensure that African smallholder farmers, in particular, do not lose local banana varieties that provide year round staple food for many of the continent's people.

So says plant disease expert Prof Altus Viljoen of the Department of Plant Pathology, whose research group is part of a consortium of scientists working together to contain an exotic fungus from Asia, called *Fusarium oxysporum* f. sp. *cubense* 'tropical' race 4 (Foc TR4). The fungus causes Fusarium wilt, also known as Panama disease, which affects most types of bananas, including the popular Cavendish banana. Viljoen's research group has gained worldwide recognition for their research on this disease. A collaborative effort is however needed to deal with Foc TR4 in Africa as is seen in the African Consortium for Foc TR4 (AC4TR4), a grouping that combines the expertise and efforts of scientists and government representatives from eleven southern and eastern African countries. Foc TR4 has already killed more than a million banana plants on two commercial banana farms in northern Mozambique. Disease resistance is the most effective way to manage Foc TR4, but not all resistant varieties are high-yielding and popular with consumers. "Our challenge is to find or develop resistant varieties of which the fruit is acceptable to both producers and consumers," explains Viljoen.

Another fungus that severely threatens South Africa's exports of fresh citrus especially to the European Union, is citrus black spot (CBS) caused

by the fungus *Phyllostica citricarpa*. The fungus only causes small black spots on the fruit rind and while these are only cosmetic and do not cause decay or off-flavours, the EU regards CBS as a quarantine disease and a single spot on a piece of fruit will get whole consignments rejected.

Prof Paul Fourie and his team at the Department of Plant Pathology, together with Citrus Research International have been studying various aspects of CBS to support prior scientific understanding that *Phyllostica citricarpa* does not cause disease in winter rainfall areas. Epidemiological models have been developed to prove the relative unsuitability of climates in EU citrus-growing areas compared with those in summer rainfall areas where CBS occurs. These models were also programmed to give growers CBS forecasts based on weather conditions, which can be used as a tool for management and risk assessment. In order to better understand CBS epidemiology and possible mechanisms of spread in an orchard, in a country and globally, researchers developed genetic markers to describe the population genetics in this fungus. This led to collaboration with European scientists in a study that detected *Phyllostica citricarpa* in Portugal, Malta and Italy. On a more applied level, the effects of postharvest handling and treatments was studied: CBS was effectively controlled and lesions that did escape treatment mostly could not reproduce, further strengthening assurances that citrus fruit is not a pathway for the spread of the fungus, especially with fruit that has been commercially produced for export and subjected to pack house treatments.

These valuable research outputs are used by citrus growers to better understand and control CBS, and importantly also used by South Africa to negotiate market access. The EU has however retained legislation that severely restricts import of citrus fruit from production areas where CBS occurs.

# 32

## GENES

The genetic code is the blueprint for everything that happens in the cell, including our reaction to environmental stressors, including infections. The focus of the Tuberculosis Host Genetics group led by Prof Eileen Hoal van Helden of the DST-NRF Centre of Excellence for Biomedical TB Research, is on finding the genetic underpinnings of tuberculosis (TB). The group investigates human genetic susceptibility to TB by conducting case-control and family-based association studies to find genes that contribute to the risk of contracting TB, and intermediate phenotypes which may identify these genes, or determine the reaction to vaccines and TB drugs.

Although one third of the world's population is infected with *Mycobacterium tuberculosis*, the vast majority will never develop the disease. Inter-individual variation in the immune response plays a major role in determining different clinical outcomes in infected persons. "We aim to identify these host genetic factors influencing immunity by studying the complete susceptibility spectrum, ranging from individuals with rare susceptibility mutations to common genetic variants in the general population," explains Hoal van Helden. "We have over 4 000 individual DNA samples and phenotype information that allowed us to establish a databank comprising association data, single nucleotide polymorphism microarray, and next generation sequencing data from South African populations.

The group was also central to the discovery of a new paradigm in the immune response to TB. A genome-wide linkage scan on the tuberculin skin test (TST) showed that about 20% of subjects exposed to TB had a negative TST,

appearing to be naturally resistant to infection. These findings led to funding received to investigate the phenotype in 1 000 HIV positive individuals, in order to find the resistor phenotype.

Hoal van Helden explains that while most of their investigations previously focused on the common genetic variants that predispose the general population to pulmonary TB disease, it now includes susceptible individuals with rare mutations (i.e. primary immunodeficiencies or (PID)) and individuals with extreme forms of the disease, such as tuberculous meningitis. "Our PID investigations allow us to directly contribute to patient diagnosis and management. These inborn disorders of the immune system cause increased susceptibility to bacterial, fungal and viral infections," says Hoal van Helden. Many of these disorders are treatable, some even curable, and their treatment and management is often informed by rare and hard-to-find disease-causing genetic mutations. The group identified several PID-causing mutations that have had a direct impact on patient treatment which included two successful hematopoietic stem cell transplants. "In addition to this, we have identified novel PID-causing mutations that has given us new insights into established immunological pathways," Hoal van Helden concludes.

In 2007, a rogue form of the Transient Receptor Potential Melastatin 4 (TRPM4) gene was for the first time reported to cause a human genetic disease. The disease in this case was progressive familial heart block type I (PFHBI) (coined 30 years earlier by Prof Andries Brink, former dean of SU's Faculty of Medicine and Health Sciences. PFHBI is a strongly inherited conduction disease. When it progresses to complete heart block (CHB), interruption of the electric signal of the natural heart pacemaker to the ventricles, the main pumps of blood, leads to an abnormally slow pace and an inadequate amount of blood being pumped. Prior to synthetic implantable pacemakers to speed up the heart, onset of CHB led to blackouts, so-called Stokes-Adams attacks, and often death. The disease has been detected from before birth to old age.

The origin has been traced to a couple living in the southern Cape in the 1700s, and is another example of an Afrikaner founder effect. Disease, rare elsewhere, when present by chance early in the establishment of a new and fast-growing population leads to high prevalences.

A group led by Prof Paul Brink and Prof Valerie Corfield in 1995, reported mapping the gene to an interval on chromosome 19 containing an estimated 80 genes, most at that time uncharacterised and of unknown function. Progress was dependant on gene information becoming available through the ongoing human genome project. Evidence for the rogue variant being the cause was its absence in the unaffected and the general population, a gene product (protein) that were shown to be preferentially present in conduction tissue, and differences in electric behaviour between cells containing the rogue variant versus the normal.

Together with Prof Hanlie Moolman-Smook and Dr Marshall Heradien globally significant contributions were made in other inherited heart diseases, such as long QT syndrome and hypertrophic cardiomyopathy. Founder effects have been identified in all off these. Sheer numbers permitted researchers to address the issue of persons sharing the same defect, yet displays significant variation in disease severity, ranging from clinical normal to severely affected.

#### **DST-NRF CENTRE OF EXCELLENCE FOR BIOMEDICAL TB RESEARCH (CBTBR)**

The CBTBR led by Prof Paul van Helden since its inception until 2016 (since 2017 under the leadership of Prof Gerhard Walzl) combines clinical grassroots investigations into TB with sophisticated laboratory research that involves various departments and disciplines within and beyond the university campus. Whereas much of the work of the CBTBR entails the development of accurate diagnosis and appropriate therapy for MDR and XDR-TB, the Centre also plays an ongoing role in community outreach and awareness to prevent and treat TB. The CBTBR research focus areas are biomarkers (identifying biomarkers for

protective efficacy and identification); drug resistance (causes and spread); drug discovery and development (identification of new molecules, clinical trials to evaluate new compounds) and host-directed therapy (studying fully protective innate immune responses to TB with the aim of producing host-directed therapies).



## **GENDER**

The importance of feminist research is the acknowledgement that women are 'knowers' and knowledge producers and therefore makes an important contribution on an epistemological level. It also corrects the distorted knowledge about women in mainstream research and fills the void left by the exclusion of women and women's knowledge. In political science it makes a significant contribution to design policy interventions to deal with gender inequality. So says Prof Amanda Gouws of the SU Department of Political Science and holder of the SARChI Chair in Gender Politics.

In an article published in 2016 in the *Review of African Political Economy*, Gouws argued that different forms of mobilisation have different outcomes regarding interventions to stop violence. Campaigns, like the Shukumisa campaign, a coalition of over 60 organisations across South Africa working against sexual violence, engages the state and law reform from a feminist perspective and attempts to give women an authentic voice and equal participation in requests for new legislation and intervention. The ANC Women's League (ANCWL) on the other hand uses a nationalist-cultural frame to mobilise women. This framing of women as mothers and

caregivers silences voices that want to see state intervention deal with men's hypermasculinity and power in intimate relations.

Gouws found that while both types of mobilisation engage the state, the Shukumisa campaign depends on the parliamentary law-making schedule that constrains activism, while the ANCWL's activism is devoid of a feminist understanding of gender-based violence (GBV) and constrained by a compliant state shaped for the purposes of showing patronage to ANC members.

Shaped by the institutional context of government, the ANCWL has established a collective identity while their access to the state has given them ample resources and political opportunities. It is through this collective identity that they can mobilise women. The Shukumisa campaign on the other hand does not have a collective identity and the loose way in which it operates makes it so much harder to gain access to the state. Gouws recommends that new strategies that combine activism with access to the state and that take into account policy logics as well as the need for visible protest action, need to be devised for struggles around GBV.

Reflecting on gender integration in the South African armed forces, Prof Lindy Heinecken of the Department of Sociology and Social Anthropology contends that despite their increased numbers in the South African Defence Force (SANDF), women continue to face many challenges that affect their acceptance. Patriarchal attitudes affect authority relations and women report that they are often not respected, or that their instructions are ignored. Different forms of gender and sexual harassment are used to belittle women. Added to this the research found that women need to embrace masculine values to be seen as capable soldiers, which reinforces authoritarian masculinity and military culture. The fact that masculine traits continue to be valued more than feminine traits has meant that women in the military have not been able to bring about a more gender-balanced or androgynous military culture. Heinecken believes that where hegemonic masculinities remain

Proof-of-concept biological sensors developed by SU researchers use both nanotechnology and microbiology to enable fast, accurate and more affordable diagnosis of patients.

MICROBIOLOGY [53][56]

at the heart of military culture and the value of the female voice and contributions remain unappreciated, it remains difficult (but not impossible), to infuse alternative values.

While great strides have been made in the SANDF in improving the number of women serving in the military, the ultimate goal of gender mainstreaming remains elusive. The only way to challenge this is for women to assertively influence organisational practices and decision making. Few are prepared to do so, as this may result in their effective segregation, either imposed from the outside or self-induced. The easier option to be accepted is to stylise their behaviour in accordance with the identity practices of the masculine image of the (combat) soldier. This hinders the displacement of gendered dichotomies necessary to transform the manner in which military personnel are socialised into becoming soldiers. Consequently, Heinecken believes that one cannot say that gender equality and the goals of gender mainstreaming have been fully realised in the SANDF, or elsewhere for that matter.

### SA RESEARCH CHAIR IN GENDER POLITICS

This Chair, led by Prof Amanda Gouws and situated in the Department of Political Science, fills the gap that exists in gender-related research and will broaden research access for gender scholars. Most very serious societal problems in South Africa are deeply gendered problems (such as gender-based violence, poverty, land and health issues). In order to deliver a better understanding of women's citizenship, research will focus on the experiences of women in the political system through representation, the accommodation of their needs and demands in governmental policies, and women's activism that mobilise demands so that these demands can be included on the political/policy agenda.

# 34

## GENOMICS

When most people think of DNA what comes to mind is the helical molecule that genes are made of and the way that genes determine how individuals look, behave, or what their risk for developing disease might be.

However, DNA can tell us much more than just the biological disposition of an individual or their offspring as individuals do not exist in isolation, but as 'members' of populations of a species. An integrative understanding of genome function and population dynamics has led to the development of a new hybrid discipline, population genomics, which lies at the juncture of modern molecular bioscience and classical evolutionary biology.

Dr Clint Rhode, from the SU Department of Genetics, is particularly interested in the population genomics of marine animals of economic importance, and has recently pioneered this approach for genetic investigations in the South African abalone. His studies revealed that the two major reproductive stocks of abalone along the South African coast is likely adapted, through differing mechanisms of energy metabolism, to the oceanic conditions created by the warm and cool ocean currents on either side of Cape Agulhas. The genetic evidence also suggests that the populations are responding to yet unknown environmental permutations (that may be anthropogenic) and that the species is under threat due to a low number of effective breeders in the short-term.

These results have particular implications for the sustainable management of the abalone resource. Studies on commercially farmed abalone have also shown that adaptation to the artificial environment might be fairly rapid and has identified genetic elements that

could be used to increase commercial production. Rhode is expanding his research to include marine species such as scallops, cob and yellowtail fish.

Animal scientists and geneticists in the Departments of Animal Sciences and Genetics are also playing their part in developing South Africa's Livestock Genomics Initiative. This initiative, driven by government, industry and academia, was set up to enhance local breeding methods and capacity. Livestock genomics is all about the genes (and therefore the hereditary qualities) of specific livestock such as cattle, chicken and sheep that are farmed within South Africa. Work done through the various partners combines the already available phenotypical (observable and measurable breeding characteristics) information about specific breeds with genetic information to obtain the genomic Estimated Breeding Value (gEBVs). With a gEBV for each breed, farmers and producers can more accurately rank their livestock based on their genetic merit, and therefore their suitability to breed with. Prof Kennedy Dzama, of the Department of Animal Sciences, is one of the task team members, along with researchers from the University of Pretoria, the Agricultural Research Council, breeding organisations like Breedplan, leading breed societies and SA Studbook.

"Research done at SU on the genetic characterisation of SA livestock breeds such as Nguni cattle, major sheep breeds like the Dorper, SA Merino and Dohne Merino, and indigenous chicken and pig breeds, use both molecular techniques and quantitative approaches," Dzama explains. "This will hopefully provide the backbone on which the reference populations for genomic selection and future breeding efforts will be built, so that South Africa can join other top livestock producing nations in the world of genomic selection."

### THE USE OF REMOTE SENSING IN AFRICAN CONSERVATION EFFORTS

An investigation by Dr Helen de Klerk of the SU Department of Geography and Environmental Studies into the use and uptake of remote sensing (RS) in African conservation and ecology for the Zoological Society of London was published in the journal *Remote Sensing in Ecology and Conservation* and found that conservationists in Africa want to use RS to improve their monitoring and planning, and are doing so. The African conservation agencies interviewed indicated that field staff use RS products or tools to aid their daily core functions. One of the benefits of the increase of freely available RS imagery is that it is updated frequently and provides continuous coverage of larger areas enabling field staff to use it to map important land cover features such as wetlands, vegetation, fire scars and patches of invasive alien plants, and infrastructure, roads, trails, and fire breaks. It has also seen a dramatic uptake in published research in African conservation and ecology. Between 2000 and 2015, there has been a five-fold increase in publications using RS in conservation and ecology studies in Africa. Encouragingly, authors with addresses in African countries accounted for 51% of records, with 20% of the literature led by authors in South Africa, while authors in Kenya produced 6%. Authors in Ethiopia and Tanzania each produced 4%. A steady growth of publications on conservation and RS is seen in South Africa, but not in Kenya, Ethiopia or Tanzania.

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## GEOGRAPHICAL ANALYSIS

This past year South Africa has been in the grip of a severe drought and as a consequence, large rain-fed agricultural areas have been greatly affected. Many irrigated areas have also been affected adversely, resulting in water conservation measures and water restrictions imposed, with water supplies substantially cut.

These realities and uncertainties in various sectors about practically achievable targets for expansion of irrigation, and about the accuracy of the total hectares under irrigation exposed the need for a more detailed analysis and verification of available information.

Now a Water Research Commission (WRC) project is using an 'eye in the sky' approach to develop a methodology that would allow the area under irrigated agriculture to be mapped on a regular basis, while also estimating the volume of water used. The project: Wide-scale modelling of water use and water availability with earth observation/satellite imagery, is jointly funded by the Water Research Commission and Department of Agriculture Forestry and Fisheries, and is being conducted by a collaborative team under the leadership of Prof Adriaan van Niekerk of Stellenbosch University.

Technology was developed whereby irrigated areas can be cost-effectively mapped at national scale and on a regular (even monthly) basis. This makes it possible to quantify how much water is being used by irrigated agriculture at any point in time. At the same time water accounting makes it possible to calculate how much water is being used by other land uses and how much water (if any) is available for additional irrigation.

It was observed that only 1,1% of South Africa's total land surface and only 10% of South Africa's agricultural land is being irrigated. This means that – because of the relatively small area that is being irrigated – the water used for irrigation (of total available water) is relatively small. Compared to rain-fed crops, the water used for irrigated crops is not much more (e.g. irrigated wheat uses on average only about 20% more water than rain-fed wheat), and because of their large coverage many other land uses (e.g. forestry and even conservation areas) 'use' much more water than irrigated agriculture. The study found that infrastructure such as dams are needed in areas where there is sufficient water to expand irrigation.

Other CGA projects, all based on earth observation and satellite imagery include: investigating what impact climate change might have on water use; monitoring irrigated areas that are affected by salt accumulation and water logging as this has an impact on yields; estimating wine grape yields using satellite imagery; determining the water footprint of wine and table grapes; estimating sugarcane yields using satellite imagery and mapping and monitoring crop types using satellite imagery.

### CENTRE FOR GEOGRAPHICAL ANALYSIS (CGA)

The CGA specialises in the application of geographical information systems (GIS), satellite remote sensing and other geographical-analytical techniques. It is a self-funded research institution of Stellenbosch University, seated in the Department of Geography and Environmental Studies. It aims to be the recognised training and research centre for Africa in the field of spatial information management in order to understand and manage geographical phenomena and processes to the advantage of the southern African community. The CGA undertakes research and training on request from academic, private and public institutions.

## 36

## HUMAN DIGNITY

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As part of ongoing research by the Faculty of Theology on human dignity, representatives from the Faculty and the Protestant Theological University in Groningen, Netherlands met in May 2015 and 2016 to reflect on the concept of compassion, and how one is to think about this important, though complex notion in terms of, for instance, the escalating refugee crisis that has become a global phenomenon. The essays from these consultations were collected in a volume currently in production with the title, *Considering Compassion: Global Ethics, Human Dignity, and the Compassionate God*.

Building on the successful MTH in Gender and Health, a Gender Unit was established at the Faculty in 2016 that serves as a creative space for conducting interdisciplinary research on an intersectional understanding of gender. The research conducted by the Unit is grounded in a commitment to affirming the human dignity of all people regardless of their gender, race, class, sexual orientation, marital status and religion; an ethos of consistently working for gender justice and a transformed community, and a conviction that education is instrumental for transformative change to occur. A collection of essays from the conference: *Cultivating Change Agents: Mainstreaming Gender and Health in Africa*, held in 2017 by the Gender Unit will appear in a forthcoming volume, *Change Agents in Contexts Near and Far: Teaching Gender, Health and Theology in Africa and Beyond*.

With generous support by the Alexander Humboldt Foundation, an international conference in 2015 on the theme of feminist biblical interpretation and the Old Testament, brought together members of five countries to reflect on

this one question: “What constitutes the feminist framework with which you read the Old Testament?” Contributors were asked to reflect in the first instance theoretically on their definition of feminism and how it relates to the various intersections at which they read the Old Testament, and secondly, to choose one Old Testament text to illustrate the framework/prism/optic which governs their interpretative practices. The original group of contributors were expanded to include some of the most exciting feminist and postcolonial biblical scholars today with the collection of essays published in the volume *Feminist Frameworks and the Bible: Celebrating Intersectionality, Interrogating Power, Embracing Ambiguity* (2017).

Building on a six-year collaboration between the Faculty and the Protestant Theological University in Kampen, Netherlands, a collection of essays that explores the theme of human dignity and violence in the context of the family as well as society has appeared as part of the Semeia book series of the Society of Biblical Literature in 2013. The volume, *Fragile Dignity: Intercontextual Conversations on Scriptures, Family and Violence* explores the theme of human dignity and violence in the context of the family as well as society.

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## HUMAN RIGHTS

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Human rights expert and holder of the HF Oppenheimer Chair in Human Rights Law, Prof Sandra Liebenberg, believes that although there has been landmark successes in human rights jurisprudence under the 1996 Constitution, the reshaping of our entire legal system to respond more effectively to the conditions of structural poverty and

inequality in our society remains a critical challenge. Her research focuses on the implementation, monitoring and enforcement of socio-economic rights as human rights. She played an important role in the inclusion of these rights in the Bill of Rights in the 1996 Constitution, serving as a member of the Technical Committee advising the Constitutional Assembly on the Bill of Rights.

Liebenberg has been involved in a number of landmark socio-economic rights cases which have been decided in the Constitutional Court through assisting in the drafting of *amici curiae* (friend of the court) submissions in cases such as Grootboom, Treatment Campaign, and Occupiers of 51 Olivia Road. In addition, she has served on the board of directors of a number of human rights NGOs involved in socio-economic rights advocacy and litigation, as well as the boards of several national and international human rights law journals.

She believes that a combination of pro-poor public institutions and a mobilised civil society is needed to help realise socio-economic rights such as housing, health care and education: “We need strong and ethical state institutions; a judiciary that develops robust standards and remedies to hold both government and the private sector to account when they violate these rights; and empowered civil society organisations to monitor and advocate for the rights of impoverished communities.”

In 2017, she was elected by the United Nations Economic and Social Council to serve as a member of the UN Committee on Economic, Social and Cultural Rights, the body responsible for overseeing state parties’ obligations under the International Covenant on Economic, Social and Cultural Rights. Her current research is focused on the contribution of the Covenant to developing innovative mechanisms for monitoring and adjudicating economic, social and cultural rights at a global level. Liebenberg notes: “The Committee has played an important role in promoting the equal status of economic, social and cultural rights under international human rights law. The Covenant inspired many of the socio-economic rights provisions in our own Constitution, and my work

Encouraging results of SU research showed that antiretroviral drug resistance is not yet a major problem for most South African HIV patients.

HIV/AIDS [41][27][91][20]



enables me not only to contribute to the protection of economic, social and cultural rights globally, but also to research how international law and South African law can complement each other in developing more effective ways of protecting these rights.”

#### HF OPPENHEIMER CHAIR IN HUMAN RIGHTS LAW

This Chair, held by Prof Sandra Liebenberg, was endowed by the Oppenheimer Foundation with the aim to contribute to deepening a human rights culture in South Africa through high quality research and contributing to public debate and advocacy on human rights.

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## HUMAN SECURITY

The Centre for Military Studies (CEMIS) was established in 1991 as a fully-fledged research platform between the SU Faculty of Military Science and the South African National Defence Force (SANDF). The primary objective of CEMIS was to establish a reputable research platform that could conduct cutting-edge research on military and defence matters. CEMIS partners and stakeholders include members of the military and security community, civil-military practitioners, think tanks, universities, and other clients such as students.

CEMIS currently has six permanent researchers, several research fellows and two postgraduate assistants. The main themes of research are diplomacy, development, defence, (human) security and civil-military relations as well as conflict and peace on the African continent. Projects completed and underway include topics such as health and development, economic security, the role of education, private military security

companies, international economic developments, and development challenges on the continent within a broader international setting that may impact security.

The Security Institute for Governance and Leadership in Africa (SIGLA@Stellenbosch) is a research institute of Stellenbosch University located at the Faculty of Military Science, Saldanha Campus. The patron of SIGLA is President Joaquim Chissano, former Mozambique head of state and recipient of the 2007 Mo Ibrahim Prize for Achievement in African Leadership.

SIGLA became a designated centre of excellence of the Faculty of Military Science and operates as a virtual research body under Prof Samuel Tshehla, Dean of the Faculty of Military Science. SIGLA's management aims to generate knowledge resources in the areas of security for sustainable development.

SIGLA has embarked upon a number of initiatives. These initiatives include formal Memoranda of Understanding and partnerships directed at leadership, landward and maritime security governance. Other successes are the contract appointment of two senior academics to develop the landward and maritime security governance hubs, appointment of two extraordinary associate professorships and seven research fellows from Denmark, Wales, the United Kingdom, Kenya, Ghana, and South Africa respectively. These appointments increased SIGLA's international reach and accredited research output.

Institutional partnerships include workshops with the US Embassy in South Africa on crime mitigation at sea and on land. SIGLA hosted round table discussions on African security in partnership with the Royal Danish Embassy in South Africa during 2016/17 and cooperated with the UN Office on Drugs and Crime (Kenya) in September 2017 through a lecture series and publication on maritime security off Africa. On the landward side SIGLA, in cooperation with the Royal Danish Defence College in Copenhagen, hosted the 5th International Conference on Strategic Theory in

Addis Ababa during September 2017 under the title: *The African Security Triad: From leadership to landward and maritime security governance*. SIGLA also presents the Africa panel at the annual maritime security conference hosted by the NATO operational training base in Crete, and is a partner institution in the Safe Seas Project on maritime security governance capacity building funded by the British Academy.

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## HEARING IMPAIRMENT

Online mathematics assessment (OMA) could help improve the mathematics performance of deaf and hard-of-hearing learners in South Africa. This is one of the key findings of Nolan Damon's doctoral study in curriculum studies at Stellenbosch University.

“OMAs can help deaf and hard-of-hearing learners to understand difficult mathematical concepts and provide them with equal opportunities to do well in formal mathematics assessments,” says Damon who is a mathematics teacher and blended-learning designer and trainer from Worcester.

Damon investigated the use of OMAs as an alternative form of assessment to current pencil and paper-based mathematics assessments which do not provide deaf and hard-of-hearing learners with a fair chance to showcase what they have learnt.

“These learners perform poorly in traditional mathematics assessments because they struggle to read and understand written texts and to interpret mathematics questions since neither Afrikaans nor English is their home language,” says Damon. This is partly due to the difference between the

### ACADEMIC SUPPORT TO HEARING-IMPAIRED STUDENTS

Dr Diane Bell's desire to see many more hearing-impaired students granted access to universities, led to her study to uncover ways to improve academic support for these students. At the time of the study Bell was at the Department of Curriculum Studies. She made practical recommendations to achieve a more inclusive and accessible higher education system in South Africa and to change the current reality and potential future for students with hearing impairment. She is currently the director of the Carel du Toit Trust (where deaf children learn to speak), consults for WHO and is a member of the Presidential Working Group on Disability. Six major findings emerged from the study – all of the participants felt they belonged to the 'hearing' rather than the 'deaf' identity community; curricula do not support their communication needs; existing university support services were largely inadequate; they experienced many teaching, learning and assessment barriers, and they had to develop personal coping strategies to 'survive' in higher education. From these findings, a learning support framework and guidelines for teaching students with hearing impairment in higher education was developed, and recommendations such as real-time speech to text conversion has been implemented at SU. This comes at a time in South Africa where the publication of the White Paper on the Rights of Persons with Disabilities (2015) placed the responsibility on universities to respect the rights of students with disabilities, and to ensure that they have full access to learning, information, and the teaching environment.

structure and grammar of Afrikaans/English and Sign Language, the absence of a mathematics vocabulary in Sign Language, and their limited language skills. The study highlighted the value of incorporating multimedia such as videos, images, simulations, interactive content and other graphics in conjunction with Sign Language within the OMA because deaf and hard-of-hearing learners are dependent on visual imagery for learning. Multimedia can reduce the cognitive load of interpreting texts and also enhance the learning process for these learners.



## HEART HEALTH

“As cardiovascular diseases are major contributors to global ill health and mortality, support in terms of laboratory space, equipment, facilities and personal development creates a first class and unique working environment at SU to pursue research questions regarding links between HIV and cardiovascular diseases onset,” says Prof Faadiel Essop of the SU Department of Physiological Sciences.

Despite the strong roll-out of highly active antiretroviral treatment (HAART), there is increasing evidence demonstrating a link between HIV and the development of cardiovascular diseases (CVD). The HAART-to-HEART study is currently investigating a rural HIV-positive population (Worcester, Cape Winelands region, South Africa) and recent data demonstrate that HIV-positive individuals exhibited enhanced immune activation together with increased blood clotting. This occurred despite such individuals being treated with HAART. HIV-positive individuals also displayed unique changes in lipid subclasses that were linked to the higher immune response observed. Researchers believe that such changes

increase the risk for heart diseases in HIV-positive persons, even if they receive anti-retroviral treatment. These findings reveal that clinicians should monitor/control inflammation and coagulation (even at relatively early stages) in order to improve the overall management and well-being of HIV-positive patients.

Also in the Winelands region, a study by Dr David van Velden of the SU Department of Anatomical Pathology and Prof Maritha Kotze of the SU Department of Chemical Pathology confirmed previous studies showing that moderate alcohol consumption may have a protective effect on cardiovascular health.

Whether these cardioprotective effects of red wine are due to alcohol or to non-alcoholic components such as flavonoids remains unknown. The study compared the influence of moderate red wine drinking to brandy consumption on the lipid profile. The impact of hereditary factors on biochemical markers of cardiovascular risk was also assessed, making it possible to determine the influence of genetic risk factors in response to alcohol intake. A significant increase in HDL cholesterol known to have a cardioprotective effect was observed, although to a lesser degree in the study participants with a particular genetic profile. In a subgroup of study participants with a genetic variation known to affect iron metabolism and oxidative stress, a significant increase in total cholesterol and triglyceride levels was observed.

The most important findings from this study are:

- Moderate alcohol consumption was shown to protect against cardiovascular disease regardless of whether brandy or wine was consumed, with the additional benefits of wine ascribed to the presence of polyphenolic antioxidants.
- The beneficial effect of the non-alcoholic fraction of red wine in particular, conferring greater protective effects on cardiovascular risk factors than other alcoholic beverages, was supported by the findings.
- The genetic profile influences the potential health benefits and

detrimental effects of moderate alcohol intake. Although the antioxidant effects of red wine is well documented, it seems clear that alcohol intake may be contra-indicated in individuals with certain genetic alterations that occur relatively frequently in the general population.

The study revealed that early risk detection through the identification of specific genetic markers correlating with known biochemical pathological markers for cardiovascular disease and other non-communicable diseases, makes it possible to develop an individually tailored preventative medicine programme. By performing a genetic screen of clinically relevant low-penetrance mutations, the researchers were able to identify individuals unlikely to derive cardiovascular benefit from alcohol consumption. Since genetic risk factors influence the effect of alcohol on biochemical markers of cardiovascular risk, safe limits for alcohol consumption may in future be based partly on the genetic profile or knowledge of the importance of genetic variation in this context.

“This research supports the benefits of moderate wine consumption as part of the Mediterranean-type diet in healthy individuals,” says Kotze. Further research is needed to determine whether increased cancer risk associated with alcohol intake and its effect on bone health is affected by cardiovascular genetic risk factors. “This is important as the 10-year predicted risk of cardiovascular disease in hormone-positive postmenopausal breast cancer patients equals or exceeds risk of cancer recurrence,” Kotze explains.



## HIV/AIDS

South Africa is not only the country with the largest number of HIV-infected inhabitants worldwide, but also the country with the largest number of HIV patients on treatment. But, with the current treatment programme coming of age, new challenges are emerging, most notably antiretroviral drug resistance.

Drug resistance arises as a consequence of the virus replicating at a high rate while constantly mutating. Suboptimal levels of antiretroviral agents – most commonly because of inadequate adherence – create a situation where selective pressure favours virus variants carrying chance mutations that render them less or non-susceptible to one or more of the drugs.

Testing for resistance is technically demanding and expensive. Instead of monitoring individual patients, the Division of Medical Virology of the Faculty of Medicine and Health Sciences is conducting systematic surveillance in different groups of patients. Given that the public health approach means that patients receive standardised antiretroviral treatment regimens, the aim is to generate reliable data to inform future changes to the treatment protocol.

According to Prof Wolfgang Preiser, systematic surveillance of different groups of patients showed that the prevalence of transmitted resistance in adults was low, as was initial resistance in young children, except for those who had – unsuccessfully – been administered nevirapine to reduce the transmission risk. These encouraging results demonstrate that antiretroviral drug resistance is not yet a major problem for most South African HIV patients. However, as the South African public sector treatment programme grows and the treated

### KNOW YOUR STATUS WITH THE HELP OF COMMUNITY-BASED TESTING FACILITIES FOR HIV/AIDS

Sue-Ann Meehan of the Desmond TUTU TB Centre found in her doctoral study that government clinics on their own cannot achieve the first goal of the UNAIDS 90-90-90 strategy of 90% of HIV-positive people knowing their status. She established community-based units where more than 180 000 people of which many were males, were tested. These mobile services provided opportunities for impromptu walk-in tests. Many persons tested and found positive linked up with clinics for treatment. The findings of this study provided key insights for the Department of Health.

cohort matures, more patients will develop resistance. In parallel, a larger proportion of new infections will then be acquired from those failing therapy and harbouring resistant viruses. The antiretroviral resistance testing for programmatic surveillance has been proven to be invaluable and will become even more so in future. Only continued surveillance will allow timeous detection of emerging problems and modification of treatment protocols.

### **AFRICA CENTRE FOR HIV/AIDS MANAGEMENT**

The Africa Centre for HIV/Aids Management believes academic institutions must play a creative and active role in nourishing social, political and economic transformation. This includes creating new programmes across the divides of the past, says Prof Jan du Toit, director of the Centre. Originally part of the Department of Industrial Psychology, the Centre is now a separate unit for education, research and community service related to HIV and Aids management in the workplace.

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## **INCLUSIVE GROWTH**

Although extreme poverty has decreased globally and market systems have brought greater prosperity and better living conditions for many, it has also been associated with increased inequalities.

It is estimated that in 2016, 50 per cent of the world's wealth was in one per cent of people's hands. Furthermore, poor individuals often need to incur higher costs to participate in a market economy. Poor people often only have access to poor quality goods (e.g. expired medicines, contaminated food, faulty devices and

products) and even may have to pay more for these than their richer counterparts.

This situation presents itself due to a lack of sound infrastructure, a lack of skills and awareness of possible solutions and limited resources. To respond to these challenges, there is a need for an innovation regime with novel approaches and strategies to make it possible to design and produce goods or services that can serve and even transform the living conditions of disadvantaged communities. Innovation for inclusive development (I4ID) refers to the improvement of living conditions and creation of employment opportunities for the poor through these products, services, processes and business models.

A thriving research programme has been established with students and staff from the DST-NRF Centre of Excellence (SciSTIP) that resides in the Centre for Research in Evaluation, Science and Technology (CREST) and the Department of Industrial Engineering.

The project aims to research how I4ID may provide solutions to societal problems such as access to clean water, health care, financial services, electrical power, modern communications, and education.

The initial project entitled University-driven Innovation for Inclusive Development (UDI4ID) forms part of an ongoing project with the Centre for Frugal Innovation in Africa – an alliance between Leiden University, Delft University and Erasmus University. Researchers examined the general nature of university-driven or university-supported activities with regard to inclusive technological innovations.

The project involved 15 case studies from four universities in the Western Cape Province and established that it is only through partnership, deep contextual knowledge and appropriate infrastructure that these projects have a chance to become sustainable.

This project has prompted further work in the evaluation of I4ID projects in order to have improved methods for analysing and understanding outcomes and impacts achieved. Researchers have also initiated a project on I4ID platforms and intermediaries. Here the focus is on hard and soft infrastructure and the

creation of spaces and places where learning and collaborative problem solving and experimentation can take place. The researchers are expanding the programme in collaboration with a wide range of private sector partners such as GlaxoSmithKline (through the establishment of the Health Systems, Engineering and Innovation Hub) and Vodacom/Mezzanine ware (focused on ICTS for Development) which is expected to give more momentum to their work.

### **DST-NRF CENTRE OF EXCELLENCE IN SCIENTOMETRICS AND SCIENCE, TECHNOLOGY AND INNOVATION POLICY (SciSTIP)**

SciSTIP with Prof Johann Mouton as director, has two overarching missions: to conduct and promote scientometric studies and scholarship; and to conduct and promote science, technology and innovation (STI) policy studies. These two missions are intrinsically linked. Although one could undertake scientometric studies for its own sake, their aim is to conduct scientometric studies that inform and assess STI policy as well.

SciSTIP's research focus areas include among others science in (South) Africa: history, governance, state and trends, comprising studies addressing questions of differentiation in output and how these are related to differences in institutional policies and strategies; research evaluation: assessing the uptake, utilisation and impact of research, based on the recognition of the importance accorded to governance through performance measures as a feature of contemporary science policy; and STI studies, that entail policy analysis and consider the development and direction of these policies, and their implementation locally, regionally and globally, towards the realisation of local, regional and global social, economic and political objectives.

One of the two main research aims of CREST, as the host of SciSTIP, is to conduct research on the nature of science and technology with specific reference to science and technology policy in South Africa and Africa.

Nanotechnology research at SU includes the development of antibiofouling membranes as well as targeted drug delivery systems for treatment of, among others, tumours.

# NANO- TECHNOLOGY [56][53]

### REDUCING THE RISK OF BREAST CANCER

Prof Ann Louw of the SU Department of Biochemistry and Prof Lizette Joubert from ARC evaluated the chemotherapeutic potential of *Cyclopia* extracts with regards to breast cancer. Results have shown that *Cyclopia* displays phytoestrogenic activity and also suggested that it has a similar efficacy when benchmarked against commercial phytoestrogenic extracts. One extract in particular, SM6Met, displays several estrogenic attributes that may be very valuable in reducing the risk of breast cancer. Louw's work has recently shown that SM6Met thwarted breast cancer tumour growth in two rat models of breast cancer, to the same extent as the standard-of-care drug, tamoxifen, but without producing the liver toxicity caused by tamoxifen. Furthermore, combinations of tamoxifen and SM6Met were shown to act synergistically in retarding breast cancer cell growth *in vitro*. This shows that when combined with SM6Met, tamoxifen could be used at much lower doses combatting resistance and negative side-effects.

### SOOTHING YOUR NERVES WITH TEA

Biochemist Prof Amanda Swart has provided scientific proof for the anecdotal claims that rooibos tea has a calming effect. Her work showed that rooibos tea lowers the production of cortisol, the so-called stress hormone. Cortisol is produced by the adrenal glands in the human body and although cortisol is part of the normal metabolism, stressful lifestyles can result in high levels of this steroid hormone. "The overproduction of cortisol as a result of stress can lead to a number of lifestyle diseases such as hypertension, metabolic syndrome, cardiovascular disease, insulin resistance and Type 2 diabetes," says Swart. Her research team was able to pinpoint two rare flavonoids, aspalathin and nothofagin, that influence the biosynthesis of cortisol. Aspalathin has not been found in any other plant material, while nothofagin has a very limited distribution in nature.

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## INDIGENOUS TEA

"Our continued research on the chemical composition of indigenous teas forms the basis of a highly productive collaboration between the SU Department of Chemistry and the ARC Postharvest and Agro-Processing Technologies Group (ARC)," says Prof André de Villiers of the SU Department of Chemistry and Polymer Science. New information on the phenolic and volatile constituents of these products has been gained by the development and use of advanced analytical techniques, including multidimensional liquid and gas phase separations in combination with state-of-the-art mass spectrometry (MS). "These findings are important not only in extending our knowledge on the constituents of these products, but also for their effective marketing and to improve manufacturing based on chemical data," explains De Villiers.

South Africa exports honeybush tea, prepared from *Cyclopia* plants, to more than 25 countries, and globally consumers are increasingly interested in this tea because of its flavour and health properties. Rooibos tea, made from the endemic South African fynbos plant *Aspalathus linearis*, has also gained significant status as an antioxidant-containing beverage with potential health promoting properties. Rooibos contains the unique phenolic molecule, aspalathin, and a number of additional compounds not found in common food sources.

Detailed chemical characterisation of the phenolic content of these herbal teas, such as the work done by the SU and ARC collaboration, is the first step towards documenting the protective effects of tea phenolics against the risk of lifestyle diseases, and understanding their contribution to the bioactivity of rooibos and honeybush.

Over the years, there has also been a commercial surge in skin care products containing rooibos extracts. The health properties of this herbal tea in skin products has been validated in various scientific studies; these studies have also indicated the potential of rooibos to be developed into an anti-cancer agent that can be used topically in skin. Consequently, researchers have focused on the development of rooibos anti-cancer products by using different biomarkers in cells to understand the detail of the underlying mechanisms involved in the biological activity of this herbal tea.

"Development of a rooibos anti-cancer product is an opportunity to use a South African product to prevent the local incidence of skin cancer, which is amongst the highest in the world," says Dr Tandeka Magcwebeba of the SU Department of Biochemistry. In her doctoral study she found that skin care products containing rooibos extracts may be able to prevent the development of skin cancer and delay the onset of malignant tumours. "Once the skin has been exposed to the sun's ultra violet rays, rooibos extracts will remove precancerous damaged cells and also block the onset of inflammation – the latter promoting the formation of tumours in skin." According to Magcwebeba, rooibos extracts may be more effective during the early stages of cancer development delaying the progression of cancerous cells into a tumour.

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## INFERTILITY

Research in the field of infertility is critical at this time where there is urgent need to deliver on global health sustainable development goals and improve universal health coverage. "This will require evidence-based implementable and

affordable strategies at country level – and at SU, this has been our work and focus,” says Dr Thabo Matsaseng of the SU Department of Obstetrics and Gynaecology.

Historically, women have always carried the responsibility for infertility and the psychological consequences of childless women are often unbearable as they can be blamed, stigmatised, marginalised, disinherited and isolated from the entire community, resulting in domestic violence and sexual abuse. “Some cultures see it as a big problem when a couple can’t conceive and men will try to prove their manhood through infidelity, putting both of them at risk of sexually transmitted infections including HIV,” says fertility expert Matsaseng.

It has however become increasingly clear that men are responsible in about 40% of all cases, mainly due to declining sperm counts, an increasing incidence of urogenital abnormalities and testicular cancer, and the role of environmental pollutants and adverse lifestyle factors, such as smoking and obesity.

Unfortunately the majority of childless couples can only be treated by assisted reproductive technologies (ART) which resulted in the birth of the world’s first test tube baby in Britain in 1978, but these techniques are expensive and often not widely available.

The Tygerberg Reproductive Medicine (TRM) Unit has been at the forefront of research in this field and in 1984 when, led by Prof Thinus Kruger, the Unit was instrumental in the birth of the first test tube baby in Africa. Subsequently, the SU team of clinicians and researchers pioneered the country’s first frozen embryo pregnancy, and performed the first successful microinjection procedure, called intracytoplasmic sperm injection. By injecting a single spermatozoon into the cytoplasm of the oocyte, fertilisation can be stimulated and development of an embryo can occur which can result in a pregnancy. This research underpinned the successful clinical management of hundreds of couples from Africa, and many other parts of the world, who were previously unable to conceive.

According to Matsaseng, the public private interactive model at the TRM Unit

provides affordable and accessible ART services to many of its patients that face challenges such as unemployment and cannot afford to seek further fertility assistance. The TRM Unit functions only with the fertility specialist in charge of the programme and the embryologist/andrologist whom are both full time employees of SU and the state respectively.

Another strategy in containing costs is the mild ovarian stimulation protocol to induce an adequate number of eggs to work with. Medication is limited and ultrasound monitoring is subsidised by the hospital, whereby the patient will pay according to their level of income.

Further savings are made on procedural costs, consumables and early discharge. This has allowed the Department to deliver the much needed service, to interrupt the cycle of abuse commonly seen in these circumstances, and to promote proper family planning. In addition it makes a significant contribution towards the teaching of local reproductive medicine specialists and scientists.

Current infertility research is looking at males with previous vasectomies that are now seeking fertility assistance.

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## INSECTS

Insects are the most speciose organisms on earth, making up 70% of all organisms. They dominate all but the coldest and saltiest environments. They inhabit deserts to tropical forests, and swampy pools to pounding waterfalls. They are the majority that few of us see, hidden in plain view. All terrestrial and freshwater plants, even mosses and liverworts, have associations with insects. Most plants have flowers, and their reproduction depends on insect visitors to pollinate

them, and so reproduce. Virtually all frogs and lizards need insects to sustain them. Well over half of all fish, birds and small mammals require insect food. In turn, a third of insects eat other insects. “In short, insects are the fundamental woof and weft of all land-associated ecosystems. Furthermore, we cannot live without them, as a third of our food, and especially the most nutritious components of our food, such as fruit and nuts, depends largely or totally on insect pollination.” So argues expert entomologist Prof Michael Samways of the SU Department of Conservation Ecology and Entomology. As with many scientists working on biodiversity, he sees the world as in crisis in this current age of human impact, the Anthropocene, with the impact so great that it threatens humankind’s survival.

Among the casualties are insects and other small animals. The last hundred years has seen a major decline in insects, with Germany losing three-quarters of its flying insect abundance in just the last couple of decades. Tropical forest loss is not stopping, and freshwater systems are in decline across the world. Soil, the 30 cm between life and death of the planet, is being lost in some places several thousand times faster than it is forming. “All these changes, which have accelerated the last 100 years, are leading to a monumental loss of species, the full magnitude of which we do not know. So many little animals are going extinct before they even have scientific names,” contends Samways.

This is why Stellenbosch University, especially the Department of Conservation Ecology and Entomology, dedicate a very large research programme to the conservation of insects and their small allies. This is important as South Africa has three of the world’s 35 biodiversity hotspots and is home many thousands of species that occur here and nowhere else on Earth. Their conservation is vital and urgent. They are being saved both in freshwater and on land through a host of strategic approaches, such as the setting aside of natural land in and among plantation blocks, through organic farming, and the restoration of rivers.

Leaving original, natural land, along with its streams and rivers, keeps the wheels of ecosystems turning and the land rejuvenated. These natural strips of native vegetation known as conservation corridors, act as extensions of nature reserves and so provide extra opportunities for insect life. Changing agricultural practices by moving away from conventional eco-hostile methods to organic and wildlife-friendly methods, also leads to healthier ecosystems for both the wildlife and for mankind. A further approach is to restore the land and rivers such as the project in the Seychelles where island vegetation was restored to let the native biota recover. "SU is a world leader in implementing these management and restoration strategies, and continues to make great progress towards saving insect diversity in this rapidly changing world," says Samways.

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## INVASIVE ALIENS

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One of the major impacts of humans on the planet is the changes brought about by the redistribution of species to areas outside their native range. "The movement of humans and goods around the globe is happening at rates that have never been seen before in human history," says Prof Dave Richardson, expert in invasion ecology and director of the Centre for Invasion Biology (C·I·B). "This is disrupting the age-old biotic equilibrium, and has caused many species to now occur beyond their natural ranges and to flourish there."

These alien species have in some cases caused considerable harm to the recipient systems, including driving native species to extinction, disrupting soil, nutrient and water cycles and affecting peoples' health and livelihoods.

Resources to manage these problems are limited, and it is therefore important to understand which species are, or are likely to be, the most damaging. "We need new ways of managing these pockets of emerging ecosystems that are now found within our natural ecosystems, because it is not necessarily possible to change conditions back to some historic state," Richardson believes.

But how do you compare the enormous range of impacts due to diverse alien taxa, acting on different levels of ecological and socio-economic complexity, and at different spatial and temporal scales? An international team of experts, including several researchers of the C·I·B, have proposed practical solutions to this problem by developing two classification schemes for impacts of alien taxa. On the one hand, environmental impacts are defined by scenarios describing the levels of impact on native species by different mechanisms, while another scheme for classifying impacts on human well-being is based on the capability approach.

"Scenarios are designed so that the magnitudes of impacts caused by different mechanisms and affecting different constituents of human well-being respectively are directly comparable," says Sabrina Kumschick of the C·I·B.

These schemes allow for the classification of alien species from different animal and plant groups according to the magnitude of their environmental and socio-economic impacts. They are designed to be similar in structure and logic to the widely adopted International Union for Conservation of Nature (IUCN) Red List for categorising extinction risk, and the environmental scheme was formally adopted by the IUCN as a tool to classify alien taxa according to their impacts. Like the IUCN Red List, these tools are useful to inform the identification of priority species for action, as required by international policies on biological invasions. The schemes further produce data which is used as formal indicators of progress with the identification and management of priority invasive alien species.

Richardson says that the prevalence and spread of invasive species have transformed the structure and functioning

of local ecosystems, which has already led to the reduction of runoff from water catchment areas, altered fire regimes and the suppression of local plants.

## DST-NRF CENTRE OF EXCELLENCE FOR INVASION BIOLOGY (C·I·B)

The C·I·B is an inter-institutional centre of excellence. Its members undertake research on the biodiversity consequences of biological invasions, largely through postgraduate student training, postdoctoral research projects and long-term biodiversity monitoring. The principal aims of the Centre's work are to reduce the rates and impacts of biological invasions by furthering scientific understanding and predictive capability, and by developing research capacity. It is affiliated with researchers across academic and non-academic institutes throughout South Africa, and while it is geared to understanding invasions elsewhere in Africa, the Centre works in all biomes in South Africa, including sub-Antarctic Marion Island.

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## LAND REFORM

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Property law generally, and land reform specifically, calls for constant and critical analysis. Continued research is imperative, as land reform resonates with various other fundamental rights embedded in the South African Bill of Rights, amongst others: dignity, right to family life and access to housing. "In this light research is much more than an academic or theoretical exercise, and although a sound theoretical basis is integral it has the potential to change lives and to make a real difference in South Africans' daily lives," believes Prof Juanita Pienaar, property law expert at the SU Department of Private Law.



In many parts of South Africa claims are lodged in relation to land which has been farmed for generations. Closer to home, some buildings of Stellenbosch University are found on land formerly dispossessed under group areas legislation. Can this land be claimed and if so, on what basis and what are the implications for parties involved? These are some of the questions explored in the book *Land Reform* by Pienaar published in 2014 as part of Juta's Property Law Library. The publication addresses the following questions: what is land reform, why do we need it and how is it conducted in South Africa? Ultimately, a two-pronged question is explored in the final chapter: have the developments since 1994 resulted in an aligned, sensible land reform programme; and can an argument in favour of continued land reform, albeit in a different format, still be made? Though land reform is multi-dimensional with economic, environmental, sociological and agricultural aspects, the publication is essentially a legal analysis, premised on property law specifically.

Since the publication of the book critical new developments have occurred, among others, new legislative measures aimed at regulating expropriation and agricultural landholdings, and various developments linked to communal land, traditional leadership constructs, restitution and other matters. In February 2018, Parliament passed a motion supporting the principle of expropriation without compensation, the modalities in terms of when and how to be determined through a process of further consultation.

Prof Kees van der Waal from the SU Department of Sociology and Social Anthropology believes that as the highly emotive politics on land reform unfolds in South Africa amidst questions of sustainability and economic stability, it is of high importance to understand cases of restitution and new forms of land ownership and their effects as the results of interaction between government, landowners and workers in specific local historical contexts. This understanding of local complexity is useful for the ongoing policy debates about forms of shared land ownership, property relations and social development options that make

economic sense and that provide new economic opportunities for an insecure population that has historically been alienated by the very economic processes to which they contributed their unskilled labour. The effects of recent processes of land restitution and provision of basic needs, such as housing and infrastructure, as well as the democratisation of local government and new forms of property speculation, were the focus areas of his collaborative research done in the communities of the Dwars River Valley between Stellenbosch and Franschhoek.

#### **SA RESEARCH CHAIR IN THE SOCIOLOGY OF LAND, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT**

The central concern of this Chair held by Prof Cheryl Walker and situated in the Department of Sociology and Social Anthropology, is to deepen our understanding of the complex web of social and environmental dynamics within which commitments to sustainable development must be grounded, through an investigation of these issues in and through the Karoo region of South Africa. The Karoo is of interest because of several globally networked developments that are promising major social and economic benefits both locally and nationally, and recalibrating relationships to land, environment and place. Prominent here are the Square Kilometre Array (SKA) radio telescope installation north of Carnarvon, the rise of game farming, investment in renewable energy and the possible exploration of the commercial viability of shale-gas mining.



## **LANGUAGE**

“There has been a prevailing debate on the status of all official languages in South Africa since the dawn of democracy. This is why SU as a university must be involved in the research of languages especially the three official languages in the Western Cape within a multilingual context,” says Prof Michael le Cordeur, chairperson of the SU Department of Curriculum Studies where he is also a lecturer in Afrikaans education. “It is important that Afrikaans-speaking citizens find a constructive balance. Whilst we should continue to strive for the acknowledgement of Afrikaans and other indigenous languages, we must be realistic and sensitive about the inclusiveness of communication on our campus and the role English inevitably will play in this regard,” believes Le Cordeur. Le Cordeur is a board member of the Afrikaanse Taal en Kultuurvereniging as well as the Stigting vir die Bemagtiging deur Afrikaans.

He argues that the role of language is critical to higher education as it impacts on access and success and affirms diversity, while the Constitution grants students the right to instruction in the language of their choice where it is reasonably practicable. Although there are many contributing factors, Le Cordeur believes that the language issue may lie at the heart of the education crisis in our society. “While good practices have been developed at some of the institutions, which might serve as models for change in the country, no one should underestimate the difficulties that still exist,” says Le Cordeur.

This holds true for primary education, where the principle that children should be taught in their mother tongue for at least the first six years of their schooling

# LASERS [49]

The SU Laser Research Institute is offering the only undergraduate and postgraduate programme in laser physics and laser applications in South Africa and in sub-Saharan Africa.

life is universally acknowledged but still hampered by the many unresolved issues. Prof Christa van der Walt from the Department of Curriculum Studies explains that although children generally achieve much better when they start schooling in a familiar language, the concept of mother tongue education is extremely complex. “In South Africa, where I have conducted much of my research, many parents choose to adopt a language that is not their own mother tongue as their children’s new ‘mother tongue,’” says Van der Walt.

Research again suggests that it would be ideal for children to continue learning primarily in their mother tongue once they reach secondary or high school. However, many of South Africa’s communities are extremely multilingual, which makes it difficult for schools to cater to all pupils’ home tongues. Once learners reach university, they are expected to be literate and to have built up academic language proficiency that can be continued or transferred to English. “The reality is that this is not happening – data collected by universities suggest that most applicants aren’t academically literate,” says Van der Walt. She says that schools and higher education institutions do not always exploit existing resources – such as learners’ and students’ literacy in other languages and community members who can act as language brokers – to support the development of academic literacy.

Van der Walt also argues that South Africans must celebrate all their mother languages as an important feature of their identities and destinies. “These languages and identities must be jealously guarded, not lost through disinterest and facile notions of language superiority. We need to remember that the measures taken now should result in a more equitable dispensation for future generations if we want to improve pupils’ and students’ performance in the long run,” she says. Le Cordeur confirms this: “Much work still needs to be done before we will be able to make learners and students feel at home in an Ubuntu of languages – this can only happen by means of an inclusive institutional culture which, among other things, could be expressed in everybody’s language”.

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## LASERS

“When the first ever laser light was produced in 1961 from a tiny ruby crystal, nobody could have predicted what enormous impact lasers would have on scientific and technological development. 56 years later we are still researching new ways of employing the special properties of laser light in science,” says Dr Christine Steenkamp of Laser Research Institute (LRI) of the SU Department of Physics. The LRI is supported by the CSIR National Laser Centre and benefits from the very successful rental pool programme of the CSIR that supports laser equipment for research in South Africa.

The LRI is offering the only undergraduate and postgraduate programme in laser physics and laser applications in South Africa and in sub-Saharan Africa. The LRI is also actively involved in the African Laser Centre, regularly hosting student symposia and training workshops for postgraduate students in laser-related research from all over Africa.

Research focuses on quantum control; ultrafast science where very short laser pulses are used to make movies of ultrafast processes in molecules and materials; spectroscopy and laser diagnostics that involve the use of lasers ranging from ultraviolet to infrared and terahertz radiation to investigate the structure and changes in material; biophotonics and imaging where several laser-based techniques are investigated and eventually combined to develop novel microscopy techniques; as well as laser development of CO<sub>2</sub> lasers, the so-called work horses in industry.

At the LRI, lasers provide ways to ‘see’ how ultra-fast electrons move in new solarelectric materials, to work

towards future quantum computers, to do microscopy and imaging in such a way that the limitations of lenses are avoided, and to measure how strongly a molecular motor pulls on a microscopic vesicle inside a living cell. “Some of these techniques may in future contribute to sustainable technology, as lasers have already revolutionised telecommunication, data storage, medicine, manufacturing,” Steenkamp explains. “Everyday life as we know it is not possible anymore without lasers, even if we do not notice the laser technology that is used.”

### RESEARCH CHAIRS IN LASER SCIENCE

The Department of Physics has hosted a South African Research Chair in Photonics on Ultrafast and Ultra-intense Laser Science since 2007. The central research topic of this Chair is the experimental investigation of photo-induced reactions of atoms and molecules in matter with microscopic resolution in time and space. The group is trying to understand and control the interaction of light and matter by observing microscopic dynamics such as charge and energy transfer reactions in organic molecules, solids and novel light harvesting devices as for example organic solar cells, and photo-induced structural phase transitions in inorganic and organic crystals in the context of molecular electronics. A balanced mixture of methodology development, application of established techniques and challenging and slightly more adventurous new projects are pursued.

Since 2016, Dr Hermann Uys has filled the joint CSIR-SU Research Chair in Quantum, Optical and Atomic Physics. The Chair is situated in the Department of Physics and will allow researchers to focus on the use of single trapped atomic ions for studying quantum phenomena, and on developing laboratory technologies for the field of research that can be commercialised.

## 50

**LEXICOGRAPHY**

The SU Department of Afrikaans and Dutch has a longstanding tradition in the field of dictionaries and lexicography. Prof Nicolas Mansvelt, a Dutch linguist who became the first professor in modern languages and history (1880-1891), compiled one of the earliest Afrikaans-Dutch dictionaries *Proeve van een Kaapsch-Hollandsch Idioticon* (1884). Prof JJ Smit (1919-1945), became the first editor-in-chief of the *Woordeboek van die Afrikaanse Taal*. Since then colleagues from the Department edited and co-edited many dictionaries, including the *Nasionale Woordeboek*, the authoritative *Handwoordeboek van die Afrikaanse Taal*, the learners' dictionary *Basiswoordeboek van Afrikaans*, the *Groot Tesourus van Afrikaans* as well as the innovative Afrikaans-Dutch bilingual dictionary *Groot Woordeboek Afrikaans en Nederlands*. This dictionary was a joint project between Belgium, the Netherlands and South Africa, with SU as the primary South African partner.

The most significant contribution of the Department has been in the field of theoretical lexicography, the offering of which has expanded since 1980 to include various undergraduate components, honours modules as well as the first master's and doctoral programme in South Africa. This programme is not language-specific and attracts national and international students – including ten students from Gabon who completed their PhD's in order to expand the lexicographic footprint in their home country. The supervision, research and publications in the field of metalexicography resulted in SU becoming internationally known as a so-called dictionopolis – a university renowned for its work in the theory of

lexicography. International recognition also came in the form of an invitation to become a member of EMLex, the European Master in Lexicography. This two-year master's programme, with Erasmus Mundus Funding, is unique because of its comprehensive focus on both practical and theoretical lexicography. SU, the only university outside Europe that is a full member of this prestigious programme, hosts the business meeting and annual lexicography colloquium of EMLex in 2018.

Prof Rufus Gouws, coordinator of the programme and leading international researcher in the field of metalexicography, has been invited to become editor and co-author of international publications like *Dictionaries: An International Encyclopedia of Lexicography and Wörterbuch zur Lexikographie und Wörterbuchforschung/ Dictionary of Lexicography and Dictionary Research*, a multilingual dictionary that endeavours to standardise lexicographic terminology across language borders. The international lexicography network has also been strengthened by means of Erasmus+ agreements for staff and student mobility between SU and the universities of Maribor and Ljubljana in Slovenia, Hildesheim in Germany, and Roma Tre in Italy.

International collaboration has led to the appointment as honorary professors and research fellows of leading scholars from Denmark, Spain and Namibia and they contribute to the research outputs of the Department.

## 51

**MATHEMATICS**

"Mathematics is the crown jewel of human reasoning, and mathematicians are digging deeper in the rabbit hole for wonders." So says Prof Cang Hui of the

SU Department of Mathematical Sciences. Colleague Prof Stephan Wagner echoes this sentiment: "Mathematical research is the common ground for all of science and technology. SU is fortunate to have a broad range of research activities from very pure mathematics to collaborations with other scientific fields, with a close tie between mathematicians and applied scientists from all domains."

The mathematical model for estimating the diversity of plants over a large area, developed by Hui, is an excellent example of how mathematics can be used as a cross-cutting tool to enable scientists to estimate the biological diversity of particular habitats, regions, countries and even continents, and to assess how this might be changing over time.

Increasingly, mathematical modelling is also used to identify drug targets in molecular pathways, analyse drug effects on the level of the patient physiology and treatment interventions on the level of populations. This is specifically relevant to the African continent where the successful treatment of malaria, HIV/Aids and diabetes, and combatting side effects of the relevant drugs are of major importance. Traditional modelling approaches have been disjointed with approximations used for the missing detail. This has limited achievements at every level since the description of the disease, its epidemiology and how it responds to drugs has been incomplete.

Prof Jacky Snoep and Dr Dawie van Niekerk from the SU Department of Biochemistry, and a research team aim to construct a unified framework for analyses of pharmacological effects of drugs and disease response in patients and populations. This will be accomplished by combining detailed mechanistic mathematical models of metabolism and signal transduction with statistical and phenomenological models of disease, pharmacology and epidemiology. They have made good progress in constructing a whole body model of malaria infection, identifying drug targets, and have started including pharmacological effects of antimalarials. In addition they have started construction of a muscle cell metabolism model for

diabetes and ARV research and have reproduced a number of mathematical models of the relevant disease pathophysiologies and their epidemiology.

The SU Department of Mathematical Sciences also teamed up with the Medical Research Council to research substance abuse – a major global health and social problem. Treatment for substance abuse problems have not kept up with the increase in demand, and these programmes do not operate on evidence-based models. Quantifying substance abuse is complex because the use and possession of drugs are criminal offences, and the data is often shrouded with inconsistencies. As the need to understand the problem, measure drug-use trends, design appropriate intervention measures, and evaluate the success of the interventions, forms the basis of the work done, it is important to be able to monitor drug-use patterns and predict trends over time.

Project researchers used mathematical modelling as the appropriate tool. As with many other models, these models depend on assumptions (often made for mathematical simplicity) and the estimation of the model parameters (that are often not known). Their research questioned if data on individuals seeking treatment can be used to estimate the prevalence of tik abuse in the community; and if subsequent changes in the prevalence of tik abuse can be predicted by quantifying policing levels on drug supply chains. Future work involves refining the current models to incorporate self initiations, the impact of behaviour change induced by campaigns, and age structure.

Prof Helmut Prodinger is one of the fathers of modern analysis of algorithms and analytic combinatorics. Among his many scientific achievements, his work on digital systems has been particularly influential. Digit expansions of various kinds play a crucial role in different areas of computer science. For example, suitably chosen digital systems can be used to improve the performance of algorithms in elliptic curve cryptography. “Prodinger’s work greatly improved our understanding of the asymptotic properties of such digital systems, by introducing novel techniques such as the

Mellin transform to the subject,” says Wagner. These methods turned out to be widely applicable to a great range of problems, also in seemingly unrelated areas such as the analysis of geometrically distributed random variables. His fundamental paper on applications of the Mellin transforms to digital sums has already been cited more than 100 times and continues to be the main reference in its area. Prodinger continues to inspire his coworkers with a unique approach based on a combination of intuition, computer experiments and clever use of calculations and analytic techniques.

#### SA RESEARCH CHAIR IN MATHEMATICAL AND THEORETICAL PHYSICAL BIOSCIENCES

Prof Cang Hui holds the SARChI Chair in Mathematical and Theoretical Physical Biosciences. This Chair aims to establish the multidisciplinary field of mathematical and theoretical physical biosciences as a distinct research strength in South Africa. This would support the existing research activities in this field at SU and at AIMS SA, and stimulate interaction.

# 52

## MEAT SCIENCE

Research by meat experts of Stellenbosch University who had brought the illegal practices of suppliers of processed meat to light, resulted in new meat labelling regulations specifically designed to safeguard consumers. These regulations specify that certain information must be present on the labels of all preserved, processed, dried and packaged meat products including the product’s country of origin, weight, all ingredients, as well as a description in simple language of the animal type the product was made of.

Dr Donna-Marée Cawthorn and meat scientist Prof Louw Hoffman of the SU Department of Animal Sciences collaborated with Dr Harris Steinman of the Food and Allergy Consulting and Testing Services and found that South African consumers are sometimes being misled about the ingredients found in processed meat products such as sausages, deli meats and hamburger patties. This not only violated existing food labelling regulations, but posed economic, religious, ethical and health impacts.

SU researchers also recently combined forces with Cape Peninsula University of Technology (CPUT) in ongoing research into the quality and value of snoek and other South African marine fish species. According to the findings of this study published in the *South African Journal of Science*, a snoek’s meat is quite high in protein and important omega-3 fatty acids, but low in fat. It was conducted by Suné Henning, a lecturer in food science and technology at the CPUT and Hoffman, holder of the South African Research Chair in Meat Science: Genomics to Nutrionomics based at Stellenbosch University.

Henning and Hoffman established that Cape snoek is a low-fat fish that has a fat content of less than 4%. It also has a high protein content of 24,5%, which is higher than that of other marine fish species such as European hake, seabass and cod or freshwater fish species such as rainbow trout and catfish. They further found that cooking reduces the amount of moisture available in the flesh, but increases the protein content. “The aim of this study was to determine the proximate and fatty acid compositions of raw and cooked Cape snoek. We wanted to quantify its nutritional value and make the information available to consumers and processors, so that it can be used as part of the nutritional tables of South African foodstuffs and in academic databases,” Hoffman explains.

In terms of red meat, the findings of research by Dr Sarah Erasmus provided a scientific basis for widely-held claims that there is something special and quite unique about lamb meat from the Karoo region. Her findings helped to ensure that Karoo lamb received exclusive geographic

naming rights last year in terms of European Union marketing legislation.

“To many South Africans it is common knowledge that Karoo lamb has a unique taste because of the fragrant Karoo bushes the animal eats, but reliable evidence was needed to give substance to these claims,” explains Erasmus. She used different analytical methods, such as isotopes, and completed a descriptive sensory analysis confirming Karoo lamb’s unique sensory qualities. It was proven that it has a more prominent and favourable lamb-like and herbaceous taste compared with lamb from for instance the Free State and Rûens, where the animals generally feed on grass and lucerne and/or winter grain stubble, respectively.

Erasmus’ reliable scientific findings about among others the unique sensory and regionally specific qualities of Karoo lamb led to it being granted its own unique geographic indication status in October 2016 by the European Union.

#### SA RESEARCH CHAIR IN MEAT SCIENCE: GENOMICS TO NUTRINOMICS

This Chair held by Prof Louw Hoffman works on the interaction between three focus areas: production/animal, fresh meat and processed meat/products. This research not only has the potential to produce higher quality meat products for the average consumer but will also focus on lower socio-economic groups. The Chair is co-hosted by the University of Fort Hare.

# 53

## MICROBIOLOGY

Microbiology is a vast and multidisciplinary field which overlaps with other life sciences such as genetics, biochemistry, molecular biology and even engineering. Microbiology research is key to address many of the historical and current global challenges, such as maintaining food, water and energy security for a healthy population on a habitable earth. Applying the fundamental microbial knowledge has led to the development of numerous medical, veterinary, industrial, environmental and other biotechnology applications that benefit mankind.

One such a finding confirmed that municipal wastewater may become a key ally in the fight against antibiotic-resistant disease-causing bacteria and fungi. “Certain bacteria in municipal wastewater produce antimicrobial compounds or biosurfactants that can help prevent the growth of antibiotic-resistant microorganisms which cause serious infections in humans,” says Dr Thando Ndlovu, a postdoctoral researcher in the SU Department of Microbiology. He says the rapid increase in the emergence of antibiotic-resistant bacteria was a major reason behind his search for new antimicrobial compounds. His study showed that municipal wastewater is ideal for the isolation of diverse biosurfactant-producing bacteria that could be used in the production of such compounds for commercial use.

“Biosurfactant-producing bacteria thrive in polluted environments such as contaminated soil or water. These bacteria also have the ability to outcompete other bacteria in the same environment because the biosurfactant compounds help them to absorb nutrients and to protect them from toxic

materials.” Biosurfactant compounds can be used to reduce the use of synthetic antimicrobial agents for various purposes such as cleaning agents to prevent the build-up of disease-causing and spoilage bacteria.

Prof Leon Dicks, an internationally acclaimed microbiologist and lactic acid bacteria expert has also made significant contributions to this field of study. *entiro*<sup>TM</sup> – a probiotic that provides added natural protection against gastro-intestinal disorders and boosts the immune system – is the brainchild of Dicks and his research team at the Department of Microbiology. They have been working since 2003 to identify useful strains of lactic acid bacteria, and have published more than 40 research articles in peer-reviewed journals on the two strains used in *entiro*<sup>TM</sup>.

The probiotic helps to keep the balance between good and bad bacteria in the gut, which in turn helps to prevent diarrhoea, constipation and a weakened immune system. This is due to the ability of the two strains to form a strong lining and binding to the mucous and epithelial cells of the intestinal tract. “Pathogens are unable to adhere and are suppressed,” Dicks explains. The probiotic also produces antimicrobial peptides that act against pathogens that may have become resistant to traditional antibiotics.

Dicks also collaborated with Prof Willie Perold, an internationally commended scientist in the field of superconductors and nano-electrical devices, to develop a proof-of-concept nanowire biological sensor that can identify any of the major disease-causing bacteria such as *Escherichia coli*, *Salmonella* or *Vibrio cholera* within ten to fifteen minutes. This combination of nanotechnology and microbiology could make the diagnosis of patients during an epidemic or outbreak an order of magnitude faster, more accurate and more affordable. This will enable doctors to immediately prescribe the correct antibiotic to target the pathogen, and by doing so, put less stress on the body’s immune system.

# TB IN CHILDREN [88][89]

Research at SU is focused on the prevention of both drug-susceptible and drug-resistant TB in children, given the dramatic burden TB imposes on children and families.

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## MOTHERS AND INFANTS

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As many as 250 million children across the world cannot develop to their full potential due to the debilitating impact of poverty. Malnutrition, infection, unhealthy pregnancy and birth complications, as well as an absence of stimulation and nurturing add to the loss of intellectual potential, and condemn children to impoverished lives.

According to Prof Mark Tomlinson of the SU Department of Psychology at Stellenbosch University concurrent epidemics of HIV, depression, alcohol abuse and partner violence threaten maternal and child health (MCH) in South Africa. Although home visiting has been repeatedly shown to be efficient, this efficacy disappears when programmes are scaled broadly. A study by Tomlinson, Prof Mary Jane Rotheram-Borus (UCLA), Dr Karl le Roux (Zithulele Hospital) and Dr Ingrid le Roux (Philani Nutrition Centres) in rural Eastern Cape, evaluates whether implementing routine supervision and accountability procedures will improve MCH outcomes over the first two years of life. Primary outcomes of the study are documenting maternal HIV/TB testing, linkage to care, treatment adherence and retention; and child physical growth, child functioning, and child behavior and developmental milestones.

A previous study by Tomlinson and his colleagues in Khayelitsha has shown how mother-infant attachment improved significantly as a result of an early community-based intervention. "There is evidence that sensitive maternal care and associated secure infant attachment are strong predictors of a range of child developmental outcomes, including child growth and physical health status,

child cognitive development and socio-emotional functioning," states Tomlinson. Mothers in the intervention group were significantly more sensitive with their infants, and their infants were significantly more likely to be securely attached to their mothers.

The Thula Sana intervention began in the last trimester of pregnancy and continued for six months post birth. It consisted of a manualised home-based, low-cost intervention designed to be easily implemented by community health workers working within poor communities. Before the intervention it was found that amongst mothers who were clinically depressed, relationships were often characterised by insensitive and unresponsive parenting, and that many infants were insecurely attached.

"Unlocking human potential crucially depends on reliable parental care that is sensitive to the developmental needs of children. In the context of poverty and high adversity, the capacity of parents to provide the kind of care that promotes good child developmental outcomes can be severely compromised," explains Tomlinson.

In another ongoing study, also being conducted in Khayelitsha, mentor mothers working for the Philani Nutrition Centres deliver community-based home visiting services to pregnant and postnatal mothers. In this programme, unemployed mothers from study neighbourhoods are employed and trained as mentor mothers to deliver a series of home visits to all pregnant and new mothers in their area. The visits take place from the time each mother falls pregnant until her infant is six months old. Mentor mothers are mothers who themselves come from the same adverse circumstances as other mothers in their community, but have managed to raise a healthy child despite their impoverished circumstances. The home visits were designed to be both supportive and educational in nature. A further advantage of this intervention model is that by integrating programmes for HIV with TB, alcohol and nutrition, primarily by improving parenting, HIV prevention is placed into a broader framework of community level support, free of stigma.

Maternal and child outcomes have been assessed two weeks after birth, at six months, 18 months, three years and five years postnatally. Mothers and children are currently being assessed when the children are eight years old. Across all data points there have been notable impacts of the early intervention on maternal and child health. The Philani programmes are currently being scaled-up in Eastern Cape, Swaziland and Ethiopia.

A further project, *Mphatlalatsane* or 'early morning star' has recently finished in rural Lesotho. It was a randomised controlled trial evaluation of an intervention programme which integrates Early Childhood Care and Development (ECCD), HIV testing and treatment services, and nutrition support for families with young children (ages 1-5 years). The programme was implemented in 34 villages in the Mokhotlong district of Lesotho, making use of existing village-based ECCD centres to deliver the programme to families. The intervention was designed to increase early childhood stimulation, HIV testing and treatment, and child nutrition, and was evaluated using a cluster randomised controlled trial.

This project was run by Stellenbosch University in collaboration with University College London, University of Oxford, University of Reading, and the government of Lesotho and local community-based organisations.

## 55

## MUSIC

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Published in 2013, the book, *Eoan – Our Story*, makes a unique contribution to South African music history. It shows not only how difficult it was for many people to work in the classical arts during the apartheid years, but also how music and the arts can bring meaning to the lives of



communities and individuals. Compiled as an oral history through extensive interviews with former members of the Cape Town-based cultural organisation, the Eoan Group, it has been written as a theme-based narrative and complemented by rich visual and other archival material. *Eoan – Our Story* was compiled by a committee, known as the Eoan History Project, with Dr Hilde Roos from the Africa Open Institute for Research and Innovation and Wayne Muller from Corporate Communication as editors. The committee consists of academics as well as former Eoan members who responded to an open invitation to take part in the process of making this book. Initially, acceptance for the role of SU in this project has been slow for the Eoan community, but it continues to grow as a manifestation of the University's ongoing efforts to be representative of all communities in the Western Cape and South Africa.

“While many researchers write about South Africa's history from a political perspective, my research looked at our history from the perspective that music offers. Most people listen to music, and my research shows that there is a link between the music we listen to and the values we hold.” This is the view of Dr Schalk van der Merwe, who completed his doctoral research on the history of Afrikaans music in South Africa. He analysed the interaction between political events and popular music, with specific reference to recorded Afrikaans music over the last 115 years. It started with the first recordings of the national folk songs of the Boer republics during the Anglo-Boer War and concluded with expressions of racial exclusivity in post-apartheid Afrikaans pop music. His research provides examples of the support for, and resistance against, the master narrative of Afrikaner nationalism as it existed for large parts of the 20th century, and also provides examples of how these values are still manifested in the present.

On his work and the contribution that it has made to the study of the history of Afrikaans music, as well as the impact of his research on current debates on the development of Afrikaans within university environments,

Van der Merwe says: “My research offers a critical view on, and is a deconstruction of, the white *verstaling* of Afrikaans. It is an attempt to show how Afrikaans culture was subjected to a system that wanted to send it in a specific direction. I hope it is a history that shows how wide the boundaries are of what it means to be Afrikaans.”

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## NANO-TECHNOLOGY

Polymer scientist Prof Bert Klumperman isn't daunted by big challenges – or ones on a nanoscale. Holder of the South African Research Chair (SARChI) in Advanced Macromolecular Architectures in the Department of Chemistry and Polymer Science and world leader in his field, he focuses his research on biomedical applications of polymers. His work adds to the understanding of how known polymerisation reactions work, and based on this knowledge, the team designs and synthesizes polymers that possess very specific properties.

Problems that are tackled include the development of antibiofouling membranes to prevent the growth of micro-organisms like bacteria and algae, and the design of complex molecular brushes to use in inorganic nanowires or stimuli-responsive gels. They also study targeted drug delivery systems such as so-called polymeric pro-drugs, in which a drug links to a polymer and is only released during a hydrolysis process triggered by specific conditions at the appropriate spot in the body (e.g. inside tumour tissue).

A number of patents and technologies have emanated from the Chair's research, such as a worldwide patent for antimicrobial nanofibrous membranes

that are used in the ‘teabag’ water filter developed by SU microbiologists. Applications have also been filed to use nanoparticles to extract gold from dilute solutions, for surface-modified particles that induce antibodies in animals, for a device that simplifies the extraction of samples from children with tuberculosis, and for nanosized antimicrobial membranes to filter harmful bacteria.

All over the world, operating theatres in hospitals face the problem of occasional contamination of the air with bacteria. This leads to temporary shut-down of the operating theatres, and possible health risks for patients. The solution to the problem is efficient air filtration that prevents access of bacteria into the sterile environment. Nanofibrous membranes have been developed that retain and kill bacteria. It consists of a non-woven mesh of nanofibres that result from a process called electrospinning. The mesh has pores that are small enough to retain the bacteria. To kill the bacteria, a commercially available polymer is chemically modified to provide it with antimicrobial properties. The fibres have been tested against a variety of different bacteria in collaboration with the Department of Microbiology and with TNO (Netherlands Organisation for Applied Scientific Research). Depending on the specific modification, the fibres have moderate to excellent antibacterial activity against a variety of bacterial strains, including ones that are used as biological warfare agents. “Since the antimicrobial properties are an intrinsic property of the modified polymer, there is no chance of leaching of active components, and the antimicrobial effect is permanent,” explains Klumperman. It was also shown that the fibres stay active after several washing steps.

Most of this work is being done on a nanometer scale of typically 100 to 1 000 nm. “Because we work on such a small scale, we need imaging techniques such as those provided by the Zeiss SR-Slm Elyra superresolution confocal fluorescence microscopy in the Imaging Unit of the SU Central Analytical Facilities to realistically show us what the structures we build look like,” Klumperman explains.

### SA RESEARCH CHAIR ON ADVANCED MACROMOLECULAR ARCHITECTURES

The focus of the Chair held by Prof Bert Klumperman is the synthesis and characterisation of advanced macromolecular architecture and the control of morphology and functionality on the nanometer length scale. The kinetics and mechanisms of polymerisation reactions are also investigated. One of the new research directions is the study of polymer-peptide conjugates for targeted treatment of specific diseases. The research is at the interface among polymer science, chemistry, biochemistry, physiology and in some cases, microbiology.

### SA RESEARCH CHAIR IN NANOSTRUCTURED FUNCTIONAL MATERIALS

This Chair held by Prof Leonard Barbour encompasses the study of structure-property relationships in synthetic crystals. The research involves the design of molecules that pack in the solid state such that their relative arrangements give rise to interesting and useful functionality. It also focuses on the design and assembly of these materials, and studies their structures at the molecular level with a view to understanding the direct link between form and function.

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## NEUROMECHANICS

Physical movement is fundamental to our full participation in society, and is so universal that we seldom take note of it. Nevertheless, it is a surprisingly intricate phenomenon with a complex relationship to health and performance that is not yet clearly understood.

According to Dr John Cockcroft of the Central Analytical Facilities (CAF) one of

the research fields emerging to meet this challenge is neuromechanics, which is the multidisciplinary study of how the nervous and musculoskeletal systems interact to control movement. Neuromechanics research typically requires multiple analytical techniques to be performed simultaneously and non-invasively, which is technically challenging. This includes analysis of skeletal motion, the internal and external forces producing the motion and the electrical activity in the nervous system related to motor control.

Improvements in the accuracy, connectivity and portability of analytical instruments used in neuromechanics have created new and exciting possibilities for studying movement; both in terms of more integrated and advanced fundamental science experiments as well as simpler and more ecologically valid field experiments. As a result, a unit for neuromechanics was established within CAF to accelerate multidisciplinary research in health care, engineering and sport. The unit is unique in South Africa in terms of its facilities, equipment and staff. It operates from an established laboratory on the Tygerberg campus and a large, purpose-built laboratory at the Coetzenberg sports complex, that together house a world-class array of neuromechanics equipment managed by a team of three full-time biomedical engineers.

One study being conducted at the unit is using advanced 3D-motion capture technology to develop evidence-based methods for coaching rugby goal-kicking. The major advantage of using motion capture technology lies in the ability to track changes in skeletal posture in 3D. In the rugby project, the researchers investigated patterns in the angular positions of skeletal joints and segments related to the role of the upper body and arm in preserving balance and increasing power production in the kicking leg. An analysis of the angular velocity of the joints and segments also revealed a clear kinematic sequence in which the contribution of individual body segments was observed.

The first phase of the project suggested that expert technique is highly specific to the individual kicker, which

presents a challenge to the development of standardised coaching. The unit's new outdoor-enabled camera system is now enabling a second phase of investigation where expert kickers can be compared by using data collected on the field instead of in the laboratory. Multidisciplinary collaboration between investigators of the Department of Mechanical Engineering and the Department of Sports Science has expanded the project scope and team, which now includes two master's students and a doctoral student.

The unit also houses a high-end portable analysis platform that consists of wearable sensor technologies that can be deployed in remote or uncontrolled environments. Projects planning to make use of the new unit facility include topics such as humanoid robotics design, athlete concussion, prosthetic limb testing, accelerated aging in the HIV population and balance deficits in children with foetal-alcohol syndrome. The unit is also aiming to leverage its equipment for third-stream income by delivering routine analytical services to the conditioning staff in Maties High Performance Programme and clinical gait analysis services to the Red Cross hospital for children with cerebral palsy.

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## NEWBORNS

"SU-based researchers are at the forefront of many global scientific advancements, particularly in the fields of paediatric HIV and TB care. Research on early childhood care is a strategically important focus at SU that can contribute to improved child health outcomes and ensures a healthy start in life for South African children," says Dr Angela Dramowski from the SU Department of Paediatrics and Child Health.

# GEOGRAPHICAL ANALYSIS <sup>[35]</sup>

The SU Centre for Geographical Analysis specialises in the application of geographical information systems, satellite remote sensing and other geographical-analytical techniques.

Thanks to financial support through the Emerging Global Leader (K43) Award bestowed by The Fogarty International Centre (USA), Dramowski and Dr Amy Slogrove – also from the SU Department of Paediatrics and Child Health – are now able to expand their research activities and make a lasting impact on two pressing health challenges in South Africa.

Dramowski's research centres on developing a care bundle for neonatal sepsis prevention in low-resource settings, while Slogrove is investigating the effect of hypertensive disorders in pregnancy and HIV infection on maternal, birth and infant outcomes in South Africa.

Dramowski explains that 750 000 babies die from bacterial infections in low-to-middle income countries every year. New approaches are urgently needed to prevent infection in hospitalised newborns, especially among pre-term and low-birth-weight babies.

"This award will allow us to expand our research to look for innovative ways of preventing infections and infection-related deaths in hospitalised newborns," says Dramowski. "If the care bundle is successful, we hope to obtain funding to test it on a larger scale in hospitalised newborns from other low-resource countries."

Slogrove's research, which will be done epidemiologically at a population level in the Western Cape, aims to understand whether HIV and antiretroviral therapy (ART) are associated with hypertensive disorders in pregnancy and whether this represents a pathway to adverse maternal and birth outcomes. She explains that HIV-uninfected babies born to HIV-positive women have elevated mortality and morbidity rates when compared to infants born to HIV-negative women. These trends tend to be persistent, despite improved maternal health through ART and an increased uptake of safer breastfeeding.

The award will allow Slogrove to work with leading international researchers in paediatric and maternal HIV and give her the opportunity to continue working as a paediatrician in a rural primary healthcare clinic outside Worcester.

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## PARKINSON'S DISEASE

Parkinson's disease (PD) was originally described as the archetypal 'non-genetic' disorder, but it is now well-established that this condition has a significant genetic component. The research at SU focuses on studying the genetic basis in South African patients with PD, and is of importance since investigation of the illness in local populations is likely to generate further knowledge about the fundamental molecular mechanisms of the disease. "Our findings indicate that South African patients may have novel mutations or defects and further studies are needed to identify these defects and to understand how they lead to development of disease," explains Prof Soraya Bardien of the Division of Molecular Biology and Human Genetics.

A multi-disciplinary research team led by Bardien and Prof Jonathan Carr of the Division of Neurology has been working on the genetics of movement disorders, especially PD since 2008. This research team that collaborates with other researchers at SU, is the only one of its kind in South Africa and possibly on the African continent.

PD is a debilitating and incurable brain disorder that results from the loss of neurons in a specific part of the brain known as the *substantia nigra*. Once lost, these cells never grow back. This loss results in a number of symptoms which include stiff muscles, extremely slow movements and reflexes, involuntary trembling of the body and limbs, and sufferers have difficulty in maintaining their balance. In addition to these symptoms, PD patients also experience a number of non-motor manifestations such as depression, psychosis, sleep disturbances, cognitive

decline and dementia. The prevalence of PD in South Africa is not known but it is estimated to affect at least seven million people worldwide and is found in all ethnic groups.

In the last decade, major breakthroughs have been made in the understanding of the cellular biology of the disease, largely based on the broad array of genes involved, many of which have been shown to interact with one another in a wide range of vital cellular processes.

The team's work has demonstrated that although some of the known mutations implicated in PD may also be identified in South Africa, many are not, and this appears to be particularly the case in black South Africans. In addition, they have found strong evidence for a genetic founder effect in some of the Afrikaner families with PD. This was the result of a collaborative study between Prof Gerhard Geldenhuys of the Division of Applied Mathematics and the divisions of Molecular Biology and Human Genetics, and Neurology, at the Faculty of Medicine and Health Sciences. They traced the disease in 12 Afrikaner families, back to a specific couple of Dutch and German ancestry that settled in the Cape in the 1600s and were married in 1668.

The team collaborates with GEO-PD, a worldwide consortium from six continents that shares patient DNA samples for large-scale genome-wide association studies. Most recently, this consortium has demonstrated that some genetic variants can reduce the risk of PD, an important and fascinating finding that may have considerable implications for the treatment of PD. Future GEO-PD studies are aimed at studying the interactions between genes and environmental factors, such as smoking and exposure to pesticides and herbicides.

To date, DNA samples from 1 092 individuals (comprising 623 probands) have been collected and stored. In addition, the DNA of more than 750 controls has been collected. This collection is a unique resource for genetic studies on PD. Next-generation sequencing approaches are currently being used to identify pathogenic mutations in these patients. Collaboration takes

place with many local and international researchers including Dr Ben Loos (SU Department of Physiological Sciences), Prof Francois van der Westhuizen (North-West University), Prof Matt Farrer (University of British Columbia, Canada) and Prof Owen Ross (Mayo Clinic, USA).

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## PEACEKEEPING

The sociologist Anthony Giddens reminded us that globalisation and the extremities thereof will lead to increasing divides between rich and poor especially within countries and in cases between countries. “The more people or specific communities are marginalised through hyper globalisations and the richer core states of the world, the more resistance (much of it manifested in violence) can be expected,” believes Prof Ian Liebenberg, director of the Centre for Military Studies at Stellenbosch University. He argues that one of the results of such conflict are asymmetric wars where small forces representing minorities of dissatisfied communities take on large states or even major global companies. “As a result of these developments the amount of peacekeeping operations on and off the African continent multiplied over time and the situation is likely to remain so across the globe for years to come,” says Liebenberg.

In the contemporary world of social and military conflict and the search for peace and stability, studies on peacekeeping, peace-enforcement operations and multi-national peacekeeping deployments became a focus area in subject fields such as military sociology, political science, international relations and strategic studies.

Reflecting on the role of women in peacekeeping operations, Prof Lindy Heineken of the SU Department of

Sociology and Social Anthropology explains that the United Nations Security Council Resolution 1325 call for the increased deployment of women on peacekeeping operations is partly based on the unique contribution women can make ‘as women’. The argument is made that certain feminine qualities such as being more compassionate, affectionate, sensitive, peace-loving and tolerant improve peacekeeping operations.

These qualities give women a so-called ‘female advantage’ which some claim make them more effective than men in conflict resolution, even though they may be less effective than men in combat. Other reasons put forward why more women should serve on peacekeeping operations is that they are more able to interact with the local population, improve community relations, reduce the incidence of sexual and gender-based violence, build the capacity of local women, break down traditional views that discriminate and marginalise women, and tend to defuse potentially violent situations and improve community security. Also, that having more women deployed alongside men, improves the conduct of male soldiers even where they are present in small numbers.

In South Africa, these claims have placed pressure on the SANDF to recruit and deploy more women on peacekeeping missions. However, there is some dispute as to whether women are really making a unique contribution to peacekeeping. A range of factors including language, culture and race, as well as the legitimacy of the peacekeeping forces influence their optimal utilisation. Physically, women are ridiculed by men for their lack of physical strength and endurance, especially on foot patrols and when having to spend lengthy periods out in the field. Psychologically and emotionally, the operational environment is seen to be more taxing on women, given the extreme forms of sexual violence against women and the effect this may have on the mental resilience of women. Both the threat of rape and the potential political consequences this may pose are used to justify the restricted use of women in peacekeeping. While such concerns may be justified, it perpetuates old stereotypes about men being the

protectors and women the protected, and undermines the prospect of an equal partnership between men and women in peacekeeping. This necessitates a closer introspection in terms of how women are trained, deployed and supported on peacekeeping operations if the ideals advocated in gender mainstreaming and UNSC Resolution 1325 are to be realised.

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## PHYSICS

### SU/CSIR CHAIR IN QUANTUM, OPTICAL AND ATOMIC PHYSICS

The Chair, held by Dr Hermann Uys, is situated in the Department of Physics and will allow researchers to focus on the use of single trapped atomic ions for studying quantum phenomena, and on developing laboratory technologies for the field of research that can be commercialised.

### NATIONAL INSTITUTE FOR THEORETICAL PHYSICS (NITHEP)

NITheP led by Prof Frederik Scholtz, coordinates research programmes and fosters education in theoretical physics. Its mission is to provide a stimulating user facility for theoretical physics that links South Africa and the continent to an international family of institutes for theoretical physics. NITheP is situated at SU (main node) as well as the University of the Witwatersrand and the University of KwaZulu-Natal. Research is conducted mainly in statistical and condensed matter physics; quantum information and computation; high energy physics namely string theory and matrix models as well as phenomenology.

NITheP is internationally linked with the International Centre for Theoretical Physics and constantly ranks among the top ten institutes in Africa on *Nature's* ranking of institutes.

### HOW TO REMOTELY CLASSIFY INSECTS BASED ON THE FREQUENCY OF THEIR WING BEATS AND IRIDESCENCE FEATURES

As part of his doctoral research in the Department of Physics, Alem Gebru developed a technique to remotely classify insects based on the frequency of their wing beats and iridescence features. The instrument, using laser radar and sunlight, can also determine their sex and the direction of flight. The new method promises a radical transformation of the way entomologists collect data about a large numbers of insects and their interactions. It is especially relevant in the study of pests like mosquitoes, or the well-being of important pollinators like bees.



## POLICY

The idea that knowledge, and specifically science, is a major driving force in modern societies, pervades public debate in general, and science and technology policy discourse in particular. Increasingly, the progress of societies, the quality of life of their citizens and the success of their economies are considered dependent on their ability to develop and implement effective policies and strategies for the production, distribution and application of knowledge.

When working in the policy field, one must realise that most of what you recommend will never be implemented. You can merely hope that in the process you are able to influence opinion for the better. That's the sobering advice from Prof Servaas van der Berg, of the SU Department of Economics: "However, it is very satisfying when your work does influence policy and does make a clear difference in people's lives," he admits. "Our work is unashamedly policy driven," acknowledges Van der Berg, who regularly consults with South African government departments and international organisations such as the World Bank, the United Nations Development Programme, the United Nations Children's Fund and the Southern and Eastern Africa Consortium for Monitoring Educational Quality.

Other work in the policy field includes that of Dr Lee-Ann Steenkamp of the University of Stellenbosch Business School (USB) who investigated whether replicating the tax legislation applicable to conventional oil and gas exploration would be appropriate in the Karoo scenario. Her findings were published as a chapter in the new book, *Proposed Hydraulic Fracturing in the Karoo: Critical Perspectives* (2017). Having analysed

the tax regimes of Norway and Poland, Steenkamp recommends that an appropriate fiscal policy ought to distinguish between oil and gas projects, and specifically between conventional and unconventional sources. Furthermore, shale gas projects have particularities that should be considered when designing a frack tax to encourage their sustainable development.

Contributing to policy in the health sector, research by Dr Laura Rossouw and Prof Ronelle Burger of the SU Department of Economics focused specifically on the health behaviour of pregnant women. The results of their study can hopefully guide policymakers to implement new methods to provide women with better access to health care and to alleviate workload for the overburdened public health facilities.

Researchers from the SU Centre for Evidence-Based Health Care have developed and validated a user-friendly format for presenting systematic review evidence to policymakers. Decisionmakers' ability to access the best available research on what approaches work, and integrating this evidence into their national health systems and clinical practice requires clear documentation on the relevance of the reviews and how they were assessed for their quality, impact on equity, cost implications and scaling-up considerations. To this end, researchers found that presenting evidence in reader-friendly summaries, clearly explaining the nature of the information provided and its relevance to policy decisions made this information more useful.

### SA RESEARCH CHAIR IN THE ECONOMICS OF SOCIAL POLICY

In this Chair held by Prof Servaas van der Berg, researchers study aspects of social policy and provide policy advice in the South African and wider African contexts, with a strong emphasis on quantitative, policy-relevant research, focusing also on the economics of education.

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**POLYMERS**

“Polymer science, an integral part of nanoscience and nanotechnology, is one of the strong and rapidly advancing research areas at Stellenbosch University,” says Prof Harald Pasch of the Department of Chemistry and Polymer Science. Polymer science increases the standard of living in many respects; it contributes to more secure and longer living, improved health care, and optimises use of limited resources. “Polymer research leads to novel and improved materials and products that are applied in fields such as superior lightweight materials, advanced computer technology, health care through the development of novel drugs, novel water purification systems, and green energy,” explains Pasch.

Work being done by the SASOL Chair in Analytical Polymer Science combines advanced fundamental research with novel technologies – all in an effort to provide sophisticated methods to analyse the size, composition and topology of complex polymers, nanomaterials and products being developed for the biotechnological, medical, aerospace, communication and computer industries.

To this end, methods are developed with which to better correlate the structures of polymers and nanomaterials with properties and applications in various fields. Sufficiently selective, fast and reliable methods with which to analyse the size and chemical composition of nanomaterials (in particular materials based on organic polymers and polymer-nanocomposites) are currently not available. This is a major drawback in the field of nanomaterials research and application.

The work the Chair does to address the molecular properties of complex materials by using advanced multidimensional analytical techniques

is unique in South Africa. In addition to advanced column-based fractionation technologies, a novel method called field-flow fractionation was recently introduced to separate macromolecules and nanoparticles regarding composition, and to accurately analyse nanoparticle size distributions. This is particularly important, because size distribution is a major structural parameter for nanoparticles. It is, among others, used to determine if a nanomaterial will exhibit the required properties.

Other methods currently available or under development include multidimensional fractionation methods for advanced polyolefins, which are used in cooperation with the research group of Prof Albert van Reenen in the SU Division of Polymer Science, and fractionation and analysis methods for novel coating materials in collaboration with Kansai Plascon, South Africa. The polyolefin research is conducted together with a number of major international companies, among others with SASOL (South Africa), Borealis (Austria) and SCG (Thailand).

“Biopolymers are gaining increasing importance in substituting petroleum-based polymers, not only because of their CO<sub>2</sub>-neutral production but also because of their biodegradability,” says Prof Jens Kossmann of the SU Department of Genetics and Director of the Institute of Plant Biotechnology.

The Institute of Plant Biotechnology has an impressive track record of manipulating the structural and functional properties of biopolymers to adapt their diverse industrial applications using genetically modified crops. Genome editing methodologies may now allow commercialisation of these technologies as they are considered as mutational breeding by most experts, and commercialisation of such crops does not involve immense costs for the de-regulation of genetically modified crops.

The work on starch and cell wall synthesis in crops was conducted in collaboration with Bayer CropScience and the South African Sugar Association. Work undertaken in the field of producing novel biopolymers using simple and priceworthy substrates is done in collaboration with Evonx in Germany.

Stellenbosch University is currently the only university in South Africa that offers complete and comprehensive tertiary education in polymer science and plant biotechnology. BSc Hons, MSc and PhD degrees in both can be obtained in various fields.

**SASOL CHAIR IN ANALYTICAL POLYMER SCIENCE**

The focus of this Chair, held by Prof Harald Pasch, is on the development of multidimensional analytical techniques for complex polymers. This includes the coupling of different separation methods to each other (two-dimensional chromatography) and the hyphenation of separation methods with information-rich detectors like FTIR, NMR, and mass spectrometry.

**SA RESEARCH CHAIR IN GENETIC TAILORING OF BIOPOLYMERS**

The focus of this Chair, held by Prof Jens Kossmann from the Institute for Plant Biotechnology, is on gene discovery for the biosynthesis of polymers and the use of those genes in different biological expression systems to synthesise novel biomaterials for all kinds of industrial applications. It also seeks to produce novel polysaccharides with diverse (including pharmaceutical) applications from simple disaccharides. Furthermore, they aim to establish structure-function relationships between genes, respective encoded enzymes and the resulting biopolymer in biofilms which are causing human disease such as periodontitis or cardiovascular diseases. The aim is to develop diagnostic or therapeutic tools based on functional screening of metagenomic bacterial libraries and in depth characterisation of biopolymer producing enzymes encoded by isolated genes.

The large and diverse expertise present at SU can make a significant difference between a haphazard approach and a professional response to drought mitigation, and help us manage drought conditions better in future.

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## POMEGRANATES

Recent global estimates by the United Nations Food and Agriculture Organisation suggest that up to one-third of all food produced never makes it to the consumer. This is partly due to inadequate postharvest techniques and procedures to maintain product quality and safety from field to plate. Such spoilage can cause significant postharvest and economic losses. Investments in cutting-edge research and human capacity development in postharvest technology are needed to improve the efficiency of our food system. At Stellenbosch University, the research programmes of the SARChI Chair in Postharvest Technology held by Prof Umezuruike Linus Opara, focus on finding innovative solutions to the packaging, cold storage, non-destructive measurement and prediction of postharvest quality. “The South African agriculture and horticulture sectors are highly export-oriented and this requires the application of innovative postharvest technologies across the value chain to deliver highly sought-after premium fresh and dry products to distant and highly competitive global markets,” explains Opara. He believes that research is needed to adapt existing technologies and develop new ones to help retain existing markets and access new ones.

“As professor in postharvest technology, I now have more students working on pomegranates than any other product,” Opara says. Current research includes topics such as maturity indexing to help farmers predict when fruit are ready for harvesting, determining optimal storage requirements to meet the demands of South Africa’s long supply chains to overseas markets, controlled atmosphere storage to

extend storage life, the development of modified atmosphere packaging for minimally processed fresh produce, and determining the phytochemical properties and antioxidant activities of various cultivars. This entails what he refers to as ‘agricultural engineering’ and include the design and use of sensors, mechanical equipment and improved processes on and beyond the farm to enhance productivity, quality of inputs and resources.

Innovations in nanotechnology and computer technology offer new and exciting tools to develop cost-effective and resource-efficient horticultural packaging. “Advances in packaging make a range of quality and safe horticultural products available all year round and in locations far away from the region of production,” Opara explains. “Ventilated packaging, for instance, is widely used because it improves the effectiveness of cooling processes of fresh produce inside a package.” His group applies computational fluid dynamics models that use principles of applied mathematics and physics, in an effort to help set industry standards or guidelines on the optimal vent size, number, area and location on specific packaging. Dr Karen Munhuweyi recently completed her doctoral study under his guidance on the antimicrobial effects of chitosan (a synthetic dietary fibre made from chitin which comes from the shells of crustaceans) and essential oils on reducing postharvest diseases that affect pomegranates. Pomegranates are highly susceptible to postharvest rots and decay and an analysis of pathogen incidence from orchard to postharvest showed that the flowering phase is a critical control point. Munhuweyi found that treating fruit with chitosan or a combination of fungicides reduced spoilage and extended the shelf life of the fruit up to 10 days. Encapsulating essential oils such as oregano and cinnamon into chitosan nanofibres showed good antifungal activity, increasing its potential to be incorporated into the packaging of pomegranates.

Made possible by private-public partnership funding, research tapping into the reported ‘superfood’ status of pomegranate fruit is now underway and

aimed at developing and commercialising novel value-added agro-processed products. These products will target the food, beverage, nutraceutical, pharmaceutical and beauty industries to meet the growing consumer demand for nutritious, safe and healthful products.

### SA RESEARCH CHAIR IN POSTHARVEST TECHNOLOGY

The main aim of this Chair held by Prof Umezuruike Linus Opara from the Department of Horticultural Science is to do innovative research and human capacity development to support South Africa’s agricultural and horticultural postharvest sectors. The Chair also provides a platform for interaction and multidisciplinary research by facilitating collaboration nationally, internationally, and across departments and faculties at SU. During the past nine years, the Chair has trained and mentored over 50 postgraduate students from 15 African countries, and many of these graduates now hold positions in academia and research organisations. The impacts of SARChI Postharvest Technology have been recognised through the Impact Research and Science in Africa (IMPRESSA) Award and African Union Kwame Nkrumah Continental Scientific Award for Life and Earth Science, received by Opara. The report of an independent study by the National Research Foundation on the socio-economic impacts of key national research funding instruments which evaluated Opara’s research on postharvest technology of pomegranates concluded that: “One of three research programmes of the SARChI Chair has added an estimated R65 million of direct and indirect benefits to the country, with further R90 million estimated until 2018”.

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## PRIMARY CARE

Primary care is where people encounter health services for the first time when they are sick, anxious or in need of advice or activities to prevent disease. Effective primary health care is associated with reduced inequity, better health outcomes and efficiency.

“Strengthening primary care is a national priority as this is where the majority of health problems are seen and dealt with in our health system, and primary care research is needed to achieve this,” says Prof Bob Mash of the SU Division of Family Medicine and Primary Care. It is also this Division that focuses on conducting relevant primary care research in four key areas.

Clinical research has focused particularly on patient education, counselling and behaviour change. Many of the diseases prevalent in South Africa are chronic and related to risky behaviours such as unsafe sex, tobacco smoking, physical inactivity, unhealthy diet, substance use or poor adherence to treatment. A situational analysis of primary care providers revealed that practitioners are poorly trained to assist patients with lifestyle changes and struggle to include effective counselling into their consultations. A new approach to affect behaviour change counselling was developed and an evaluation showed that practitioners could learn these skills after eight hours of training. The new model has been incorporated into the training of doctors and nurses in pre-service, in-service, public and private sectors in South Africa as well as in neighbouring countries.

Secondly, health services research has focused on the impact of family physicians on the district health services at both the district hospital and community health centre. Family physicians were recognised

as a new speciality 10 years ago in South Africa and are trained in a four-year programme as expert generalists. Decisionmakers at national and provincial levels have been uncertain as to the roles and contribution of family physicians. Four studies conducted at a national level evaluated family physicians and found that they were seen as having an impact in terms of clinical care, consultancy to the healthcare team, capacity-building, clinical governance, development of community-orientated primary care and clinical training. District managers perceived their impact on both clinical processes as well as health-system performance. Their initial impact appeared stronger in district hospitals than in health centres and particularly in the area of child health. They were still too few however to find any correlation with district level health indicators and outcomes.

Educational research has focused on defining the new discipline of family medicine and appropriate training in the African context. Nationally, research has defined the learning outcomes and clinical skills expected of family physicians in our health system and ensured that all training programmes are aligned with them. Research has also developed and evaluated a national e-portfolio of learning for registrars in family medicine. The learning needs of primary care doctors were evaluated as well as the development of a new national Diploma in Family Medicine that is aimed at upskilling and re-orientating general practitioners and medical officers for the future primary care system.

Research at SU also supports the development of family medicine in countries such as Botswana and Zimbabwe, and has led to a regional consensus statement on African family medicine from the World Organization of Family Doctors. The Division also strongly supports capacity building for primary care research at historically disadvantaged universities in South Africa, through an African network of 20 countries, through the *African Journal of Primary Health Care and Family Medicine* and the book *International Perspectives on Primary Care Research*. An international book on primary care research methods will be published later in 2018.

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## PROTEAS

For the South African Cape flora industry to be internationally competitive, it has to consistently deliver high quality stems with good storage and vase life characteristics.

Leaf blackening is a postharvest disorder that inhibits protea exports. But, research suggests that the right sugars at the right time can improve the quality and vase life of these iconic South African flowers. While some protea cultivars can be successfully shipped, there are many that suffer from leaf blackening, resulting that these flowers be shipped with their leaves removed.

Currently, the only way to delay leaf blackening in some cultivars is to pulse the cut flowers with a glucose solution for a short period, usually less than four hours, as soon as possible after harvest. Glucose pulsing is effective and reliable when administered under controlled laboratory conditions. However, it has proven to be somewhat problematic when applied on commercial scale on the farm, especially when different species, each with their own glucose concentration and exposure time preferences, are harvested at the same time.

“The reasons for these inconsistencies in glucose uptake and response are not known,” says Dr Lynn Hoffman, lecturer in the SU Department of Horticultural Science. “We also need to improve our understanding of how the flowers metabolise carbohydrates in order to offer innovative strategies to control leaf blackening. The research project investigating this issue is financed by the Post-Harvest Innovation Programme and Cape Flora SA.

As the preferred mode of transportation for Cape flora shifts from air to sea, the industry is also looking

for ways to ensure extended flower quality while simultaneously saving costs. Closed ventilation shipping could hold the key to transport that is not only more cost effective, but also better at preserving flower quality. However, the lack of information on the gas exchange dynamics of Cape flora cut flowers stand in the way of the local industry adopting this technology. According to Hoffman suboptimal shipment conditions aggravate the occurrence of leaf blackening and chilling injury. “Hence the carbon dioxide toxicity level and lower oxygen limit for the respective products are vital pieces of information.” Subsequent research showed that closed ventilation shipping is a promising technology that warrants further research on Cape flora products. It has the potential to reduce cold-storage energy costs and the carbon footprint associated with the exporting of Cape flora cut flowers, while improving their vase life quality.

The export market is also troubled by persistent pests that accompany these flowers to their new destinations. Cape flora cut flowers are grown and harvested in their natural environment, which includes the insect communities that live there. The insects of the Cape flora biome are diverse and so poorly understudied that many have not been identified scientifically. The complexity and arrangement of Proteaceae floral structures, not to mention the impressive size of some, provide ample hiding places for a massive array of arthropods. They may inhabit the stem, leaves, receptacle or inflorescence, and can occur in staggering numbers.

Two novel techniques however hold great potential for mitigating the effects of these insects, especially to markets with strict phytosanitary regulations that may result in consignment rejection.

This is particularly true for countries whose climatic conditions are similar to the Western Cape’s Mediterranean climate, and those that have their own Proteaceae or similar floral families. “The risk of South African insects establishing in overseas crops is too great for them to accept our flowers and many have a zero-tolerance approach to living and dead insect pests within

consignments,” says Dr Shelley Johnson, research fellow at the SU Department of Conservation Ecology and Entomology.

She realised that two postharvest techniques that have been approved for use in other industries have great potential for use on Cape flora cut flowers: controlled atmosphere and temperature treatment systems (CATTs) and ethyl formate (EF), a naturally occurring compound that in high enough doses prevents oxygen reaching the cells of insects, ultimately leading to their demise. Both these methods are considered environmentally friendly, as CATTs is essentially chemical free, and EF breaks down into naturally occurring harmless products. Research results from a study designed by Johnson and Hoffman indicate that in terms of flower quality, fumigation with EF has the potential to be developed as a postharvest treatment. CATTs has also proven an effective measure with which to control a vast range of insect pests that target Proteaceae.



## PTSD

Posttraumatic stress disorder (PTSD) is a severe, chronic and debilitating psychiatric disorder that can occur after exposure to a potentially traumatic event, significantly impairing normal functioning and quality of life.

South Africa is considered to be amongst the most violent countries globally, with approximately 75% of South Africans experiencing at least one traumatic event in their lifetime. South African adolescents, in particular, are exposed to high rates of trauma and are therefore vulnerable to developing subsequent psychopathologies, including PTSD.

The main focus of the neuropsychiatric genetics research group, which falls under Prof Soraya Seedat from the Department of Psychiatry’s SARChI grant, is to identify and determine molecular mechanisms that result in the development of stress-related disorders and PTSD in particular.

Family and twin studies indicate that a genetic component contributes to the cause of the stress-related disorders, but to date no gene variants have been conclusively identified as risk factors. This may be due to the fact that present candidate gene-based studies are limited in their selection of genes, given the currently incomplete knowledge regarding the pathophysiology of PTSD. In addition, the role of the environment in the study of causation of PTSD cannot be underestimated. “The overarching aim of our neuropsychiatric genetics group is to interrogate PTSD on a genetic, epigenetic, cellular and environmental level, in order to identify genomic, epigenomic, transcriptomic, proteomic and metabolomic signatures that increase risk of developing PTSD, and to clarify biomachinery underlying the disorder,” says Prof Sian Hemmings, who heads the Neuropsychiatric Genetics Laboratory, and is also from the Department of Psychiatry.

Indeed, recent studies have investigated the association between candidate genes and increased levels of anxiety sensitivity in adolescents. Their analysis revealed gender- and ethnicity-specific risks for the development of anxiety sensitivity, both with and without the interaction of childhood trauma. In addition, exciting preliminary results from a large whole-transcriptomic sequencing project on PTSD indicate that Sodium Voltage-Gated Channel Alpha Subunit 2 (SCN2A) is downregulated in PTSD individuals compared to trauma-exposed controls. “Although the results await verification, they are intriguing, given that SCNA2 is associated with neurodevelopmental disorders such as autism and schizophrenia,” says Hemmings.

In addition to this work, research by postdoctoral fellow Dr Stefanie Malan-Müller has shown that the bacteria in your gut are not only involved in metabolising food, but also influence your brain and its functioning. This is achieved through



# REPTILES [70]

SU researchers believe that studying these morphologically and ecologically diverse taxa can help us understand how and when organisms evolved and provide insight into prominent questions regarding organismal evolution in general.

### PREDICTING THE SEVERITY OF PTSD IN THE SURVIVORS OF MOTOR VEHICLE ACCIDENTS

As ten to 30 per cent of survivors of motor vehicle accidents (MVAs) continue to have PTSD symptoms for an extended period post-trauma, it is important to identify those who are at risk of developing the disorder and who may need early treatment, especially as there is evidence that early intervention strategies are useful in preventing PTSD. In order to assess the extent to which neuropsychological factors could enhance predictive power for PTSD, a longitudinal study with MVA survivors was done. "Our research found that neuropsychological, clinical, and socio-demographic factors predicted PTSD severity. This suggests that a holistic approach is needed when screening for PTSD and that early-targeted profiling of this group of trauma survivors can inform timely clinical interventions and policy," explains Dr Sharian Suliman, also a member of the Department of Psychiatry.

the complex interaction between the gut, the microbiota and the brain, in the gut-microbiota-brain axis. The investigation looked at whether the genomes of the gut microbiome were different in people with PTSD compared to individuals who experienced a trauma, but did not develop PTSD. It showed that individuals with PTSD had lower levels of a specific trio of bacteria compared to the control group, and that individuals who experienced trauma during childhood had low levels of two of the earlier mentioned three bacteria. In response to these findings a large-scale, South African population-based study to investigate the gut microbiome in individuals with anxiety and depression will be launched. "The gut microbiota can easily be altered with pre- and probiotics or dietary interventions, and we hope that our research can inform future studies to investigate how the gut microbiota can be targeted to alleviate symptoms of anxiety and depression," says Malan-Müller.

### SA RESEARCH CHAIR IN POSTTRAUMATIC STRESS DISORDER (PTSD)

This Chair held by Prof Soraya Seedat, has a strong gene-brain-behaviour research focus, and aims to identify through state-of-the-art genetic and brain imaging methods the genetic, biological and environmental factors that contribute to increasing or decreasing a person's risk for developing PTSD once he or she has been exposed to trauma.



## READING

Poor reading is a worldwide phenomenon and South African children fare particularly badly. Reading problems may also have a serious influence on

the emotional development of young children as children that struggle to read get anxious, make more mistakes and experience raised levels of stress as they are often made fun of by their classmates.

Previous research indicated that the non-critical and unconditional acceptance of the pet or dog creates calmness and boldness in children with low self-esteem and enable them to read freely, regardless of how many mistakes are being made. It was found that the blood pressure and heart rate of children who read out loud to a therapy dog are lower than that of children who read out loud to an adult or peer group.

The main objective of a study on the effect of an animal-assisted reading programme on the reading skills of grade 3 children in a Western Cape primary school was to establish the effects of the programme and to determine if it could also influence the self-concept, school attendance and performance, as well as behaviour and anxiety levels of learners. It was found that the word recognition and reading comprehension scores of the participants were higher than those of the three other groups that did not read to dogs. "This type of reading programme is flexible and can be used in different contexts, even at home. It's an easy way to help your child read better and learn to love reading," says Dr Marieanna le Roux of the SU Department of Psychology who undertook this study.

The culture of reading can also be promoted by wordless picture books, but the potential of these books to improve literacy, especially among parents and their pre-school children in poor communities, are overlooked in South Africa. This is the opinion of Dr Adrie le Roux, an illustrator from Pretoria obtained her doctorate in visual arts at Stellenbosch University.

Her study focused on the production of culturally relevant, economically viable wordless picture books to encourage a love of reading in the home, regardless of literacy levels of the parent. She says her research highlighted the potential of wordless picture books to improve the reading relationship between parents and children in poor communities.

"The visual nature of wordless picture books brings about a transformation in the reading relationship between parents and children and in the way parents viewed reading with their child," Adrie le Roux explains. "Parents who participated in the study reported that they read more with their children than before because it was easy to use wordless picture books at home. In some instances reading increased from three times a week to as much as three times a day over a five-week period. In some cases, reading became a family activity, with the older children in the family participating in the storytelling."

She adds that parents highlighted the education value of the books, felt their children were developing skills – including vocabulary and visual literacy skills – and showed increased concentration when using the wordless picture books as opposed to reading the Bible, magazines, schoolbooks or, in some cases, other picture books that contained text.

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## RENEWABLE ENERGY

Modern power generation is increasingly making use of renewable energy technologies, driven by significant technology cost reductions and a focus on cleaner energy. Research in the past focused largely on the renewable energy generation technologies themselves. As more and more renewable energy generators are connected to existing power systems, research on how to integrate renewables into these power systems is growing in importance. Specifically, the fact that some forms of renewable energy generation are non-dispatchable and intermittent,

and the generation plants generally geographically distributed rather than centralised, leads to many new opportunities but also challenges.

The SU Centre for Renewable and Sustainable Energy Studies was established in 2007 as the national hub of the postgraduate programme in renewable and sustainable energy studies. The Centre has become the best known research centre in renewable energy based at a university in South Africa, and is also internationally acknowledged as a centre of excellence in certain renewable energy disciplines.

Today it also acts as a central point of entry for the general field of renewable energy. Its research focus includes solar, thermal and photovoltaic systems; wind, geothermal and bioenergy; and using the ocean as source of energy. Projects range from initial feasibility studies for the deployment of renewable energy to highly technical studies on specific technologies. The Centre plays a facilitating role to bring new technologies to market or to assist public and private entities to deploy existing technology but with new business models.

With the ongoing drought in the Western Cape, the Centre is also focusing on the desalination of seawater using renewable energy, and is investigating the use of primarily solar energy to drive these processes. In Ghana, the use of bioenergy from the residues of agri-processing to assist developing countries to mechanise these activities was studied, and in Cape Town the energy use in low-cost houses was classified using their energy usage profiles.

In its eleven years of existence the Centre has facilitated the establishment of several renewable energy research entities within various departments of the Faculty of Engineering. These include the Solar Thermal Energy Research Group, the Eskom Chair in Concentrated Solar Power, the Scatec Solar Chair in Photovoltaic Systems, the DST-NRF Chair in Biofuels, the Eskom Power Plant Engineering Institute's Specialisation Centre for Renewable Energy, and the Eskom Chair in Power System Simulation.

Within the Department of Electrical and Electronic Engineering groups were established such as the Electrical

Machines Laboratory that focuses on the generators within wind turbines, and the Power Electronics Group that focuses on the power conversion sub-systems which is at the heart of modern PV and wind generators.

Research is not limited to the technical aspects of renewable energy – within Stellenbosch University several departments and research centres are also actively contributing to non-technical renewable energy research, ranging from finance to policy to sustainability.

### DST-NRF CENTRE FOR RENEWABLE AND SUSTAINABLE ENERGY (CRSES)

The objective of CRSES, led by Prof Sampson Mampweli, is to develop and enhance national capacity in renewable and sustainable energy in support of accelerated and shared economic growth within the area of sustainable energy. CRSES is funded by the Department of Science and Technology via the National Research Foundation and Eskom.

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## REPTILES

Dr Chris Broeckhoven of the SU Department of Botany and Zoology used innovative photography to record the behaviour of cold-blooded armadillo lizards during his doctoral study on a farm on the West Coast. More than 580 000 pictures later, Broeckhoven identified 220 000 images that he could use for analysing lizard activity. With this photographic data, Broeckhoven has overturned a few deep-rooted assumptions about lizard behaviour: "In many studies researchers assume that temperature has the biggest effect on all lizards' behaviour. I have managed to

show that, in the case of the armadillo lizard, lifestyle issues such as competition for food and avoiding predators also play a decisive role in their behaviour.”

South Africa is home to a high diversity of reptiles and includes several adaptive radiations such as chameleons and girdled lizards. Broeckhoven believes that studying these morphologically and ecologically diverse taxa can help us understand how and when organisms evolved and provide insight into prominent questions regarding organismal evolution in general. Since his work on the behaviour of the armadillo lizards he has done extensive research on the body armour of this lizard species and, together with the research team, developed a protocol to scan live lizards using the high-resolution micro-computed tomography (micro-CT). This protocol was published in *Methods in Ecology and Evolution* in 2016 and enables researchers to get more insight into the body armour of these lizards without having to sacrifice any individuals.

A study published in *The Royal Society Biology Letters*, and co-authored by Broeckhoven and Dr Anton du Plessis from the Central Analytical Facilities (CAF), showed that the structural changes associated with the formation of the venom-conducting canal in snake fangs do not appear to be associated with an increase in stress under load. The authors shed light on the pressures involved in snake fang evolution by conducting computer simulations directly on 3D-scans obtained through micro-CT.

The team tested the hypothesis that in venomous snakes, larger fangs and consequently an evolutionary shift in position from the back to the front of the jaw occurred to compensate for the costs of having highly-modified tubular fangs. Contrary to the expectations, their findings suggest that each type of fang might be biomechanically optimised. They found no differences in stress distribution between three types of snake fangs, despite differences in size and structure.

“Mankind is often fascinated by spectacular natural structures – why and how they evolved is of particular interest to scientists, and snake fang evolution is one such interesting topic,”

Du Plessis explains. Du Plessis contends that understanding the evolution of the venom-delivery system and its components could provide insights into the biological role of venom and play a vital role in facing challenges related to snake bite cases.



## RESEARCH MANAGEMENT

The Division for Research Development (DRD) is tasked with the advancement, facilitation and support of research at Stellenbosch University. The DRD aims to create an enabling environment for research and innovation by providing professional support services to three major constituencies, namely: research-active academic staff members; postdoctoral fellows; and postgraduate students. Since 2016, the DRD incorporates the Postgraduate Office.

One of its main functions is the management of research funding, including research grants as well as postdoctoral and postgraduate fellowships at institutional, national and international level. It also serves as the central support office for research contracts and funding generated through industry partnerships.

The Division is responsible for the formulation and implementation of policies related to internationally benchmarked compliancy requirements for research, and the promotion of ethical conduct of research on campus. It is similarly responsible for research strategy development and researcher capacity development, including the provision of strategic support to postgraduate students and postdoctoral fellows. The Division manages institutional research-related information and data,

and is also tasked with promoting research partnerships across disciplinary and institutional boundaries, and ensuring the visibility of SU's research.

The DRD works closely with other support divisions and the ten faculties to provide services to a client base that includes more than 1 000 academic researchers, more than 280 postdoctoral research fellows and more than 10 000 postgraduate students. It serves as institutional liaison with external funding agencies and industry partners.

The DRD recognises the importance of research, development and innovation in developing human capital for a growing knowledge economy. The Division makes a significant contribution towards a skilled and capable workforce through its emerging researchers programme. The Mellon Early Research Career Development Programme, funded through an award from the Andrew W Mellon Foundation and managed by the DRD, has made an important impact on the career development of 140 early career academic staff members over the last six years, starting in 2010. Mentees have benefited from being assigned a dedicated research mentor to advise and assist them to become independent researchers. A number of early career researchers who have benefited from this programme have obtained NRF ratings in the recent past, while others have obtained their doctoral degrees.

Postdoctoral research fellows are productive and valuable members of the SU academic community. The DRD is responsible for the coordination and management of the postdoctoral programme at SU and developed a postdoctoral research fellow policy in 2016 in order to provide guidelines for the management of relationships between postdocs, their hosts and the University, as well as to provide a framework for the successful implementation of SU's postdoctoral programme.

Apart from supporting the overall research endeavour of SU, the DRD is also proud to further support and enhance the research activities of key researcher groupings, such as our research chairs (44, of which 25 are SARChI chairs, funded by the

# SUGAR TAX <sup>[85]</sup> <sup>[18]</sup>

Studies show that sugar-sweetened beverage consumption is robustly linked to the onset of diabetes and hypertension, and SU researchers believe that the public should be pro-actively made aware of this issue.



Department of Science and Technology through the National Research Foundation (DRD coordinates the pre- and post-award processes and provides them with ongoing support), our seven centres of excellence and 457 NRF-rated researchers in 2018.

The DRD has a very specific role in the promotion and visibility of research at SU. The Division publishes this annual research report of the University, showcasing SU's research activities, as well as its excellence and relevance. This publication has won merit awards at the annual Marketing and Communication in Education competition for seven consecutive years.

The DRD also spearheaded the establishment of an extensive research knowledge directory, which was further developed and refined in 2016. This database contains key research interests and expertise of individual SU researchers. The platform is open to outside stakeholders, such as the media.

The changing landscape of higher education, with increased complexity and competition for resources, makes effective research development and support a critical success factor in research-intensive higher education institutions.

The Division actively participates in national and international forums to promote the professionalisation of research management, and to provide capacity-building opportunities for research managers and administrators. The DRD is a member of the Southern African Research and Innovation Management Association (SARIMA), members of the DRD have served on the executive board of SARIMA and regularly present at workshops and the annual SARIMA conference.

The DRD currently coordinates a large international three-year EU Erasmus+ funded project entitled StoRM (Strengthening of Collaboration, Leadership and Professionalisation in Research Management in SADC and EU higher education institutions). The overall aim of the project is to promote research outcomes, innovation and impacts through capacity building and professionalisation of a globally connected

and skilled group of research managers. The project will also support future collaborative research projects between the SADC and EU regions.

StoRM aims to change the landscape of research management in southern Africa, and potentially on the rest of the African continent.

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## RIVERS

SU conservation ecologists are taking a closer look at how the quality of river water improves once invasive black wattle is removed.

Clearing projects around rivers have been ongoing nationwide for many years in an effort to ensure water availability to South Africans. "While we know that clearing efforts improve water volume, little is currently known about the effect that these initiatives have on the actual quality of the surface water that passes through these cleared areas," explains Dr John Simaika of the SU Department of Soil Science. His research project focused on the nitrogen cycling in soils within stands of black wattle and whether clearing efforts have a positive spin-off for the aquatic plants, insects and animals that naturally occur around South African rivers.

Black wattle is ranked as one of the invasive species that have over the years caused the most damage to the distribution of riparian plants and animal life that are found naturally around the rivers of the Cape Floristic Region. It takes up nitrogen from the atmosphere and enriches the soils in which these plants grow. This process of nitrogen fixing may boost fast-growing and water-thirsty invasive plants' ability to outcompete natural riparian vegetation that ensures good water flow and quality.

"Good quality water is needed to ensure that the various life forms that rely on a river system are able to persist or return once a site has been cleared," Simaika says. He adds that the current drought conditions are a stark reminder that water is a limited natural resource and that we should take special care of it.

The project highlights that although vast amounts of money are spent on clearing invasive alien plants such as black wattle, which are touted as among the worst of invaders, knowledge of their basic ecology is lacking. By applying the principle of 'know your enemy' and understanding the ecology and physiology of Australian acacias better, new avenues for the control of these invasives, not considered before, becomes plausible.

Management recommendations emanating from the study suggest that rivers upstream of reservoirs or wetlands should be prioritised for clearing as this would reduce sedimentation and nutrient loads received downstream; riparian zones identified for clearing need to be assessed for stream bank zonation and connectivity to the main channel of the stream bank; and that invasive stands in riparian zones with low banks and high connectivity as well as stands with high connectivity and vulnerable features (such as reservoirs or wetlands) should be prioritised over all other clearing activities in riparian zones.

Clearing also needs to be adapted where connectivity to the stream is high. Research suggests that invasive stands could initially be thinned and revegetated with native fynbos plants tolerant of higher nitrogen soil content. While at first more expensive than clearing and leaving woody debris to decay, immediate revegetation may lead to more rapid recovery, and provides a quick way to stabilise stream banks.

## 73

**SATELLITES**

Three – two – one – zero, we have lift off... These words on 23 February 1999 marked SU's, and Africa's, entry into space as SUNSAT, a satellite developed by over 100 graduate students and technical staff of the SU Department of Electrical and Electronic Engineering, was lofted into space from Vandenberg Air Force Base in California. The billowing fumes were a final realisation of the project initiated in 1992 and the vision of the late Prof Jan du Plessis and former Vice-Rector Christo Viljoen.

The Electronic Systems Laboratory was formed to meet the demands of SUNSAT, and its skills have been applied to non-satellite developments including new computers, sensors, data gathering systems, flight control systems for unmanned aircraft and even remote-control units for distance education.

Many of SUNSAT's systems attracted international interest and have been supplied to other countries. SUNSAT's camera was supplied for Korea's third satellite, KITSAT-3. In December 2002, an unfolding arm, as well as a star camera developed in the laboratory, entered space on Australia's FEDSAT satellite. Opportunities for international contracting grew beyond the limits that could be handled by the University, so a commercial spin-off company, SunSpace & Information Systems (Pty) Ltd (SunSpace), was formed. SunSpace was a major funder of research in the laboratory, and supported several master's students. SunSpace was acquired by the South African government and operates currently as SpaceTeq, part of the state-owned Denel group.

SumbandilaSat, the second South African satellite was launched in September 2009 at the Baikonur

launching base in Russia. Where SUNSAT was fully established and developed from research work of lecturers and students of the SU Faculty of Engineering, the SumbandilaSat was designed and built in collaboration with SunSpace. The project leadership and technical supervision was done by SU Faculty of Engineering on behalf of the Department of Science and Technology who funded the project.

In 2014, the European Space Agency made history when they successfully landed the Philae on a comet. The Philae robotic lander and the Rosetta spacecraft were sent on their journey to the comet more than 10 years earlier. Prof Herman Steyn, currently of the SU Department of Electrical and Electronic Engineering, helped to develop and build an important part of the robotic lander. The Philae's momentum wheel, a wheel of 20 cm in diameter and with a weight of about 1,5 kg, ensured that the vessel landed on its three legs. "It feels unreal to think that the Philae's momentum wheel which I held in my hands, is now on a comet 500 million km from Earth!" says Steyn.

Today, CubeSpace, an initiative led by Steyn, is making headlines. Its ZA-AeroSat satellite, which weighs just 2 kg, was launched on 18 April 2017 from Cape Canaveral in the United States. Later that week, the Cygnus module of the rocket docked with the International Space Station (ISS), from where the ZA-AeroSat was released into orbit. The satellite forms part of the international QB50 project, which involves putting 50 satellites, each smaller than a shoebox, into orbit from the ISS to gather data on the largely unexplored lower thermosphere, between 200 km and 400 km above earth.

CubeSpace is a university spin-off company incorporated in the Innovus group and operates from the SU LaunchLab. Its ZA-Aerosat satellite is SU's third 'bird' in space, following in the trail blazed by Sunsat in 1999 and SumbandilaSat in 2009.

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**SCIENCE  
COMMUNICATION**

Over the last 20 years, science communication has emerged as a dynamic and multi-faceted field of research and teaching at leading academic institutions around the world. Following the allocation of a South African DST-NRF Research Chair in Science Communication, Stellenbosch University has become an African hub for research and postgraduate training in this field.

The Chair is hosted at the Centre for Research on Evaluation, Science and Technology (CREST) and staffed by three people: the research chair (Prof Peter Weingart), a senior researcher (Dr Marina Joubert) and a postdoctoral fellow (Dr Bankole Falade). In addition to an active and productive research programme, the Chair offers master's and doctoral students the option to specialise in public science engagement when they enrol for science and technology studies at CREST.

As an introduction to science communication as a field of research and practice, the Chair also offers a fully online course, presented over a period of six weeks, with a specific focus on science engagement challenges in the developing world. This is the first online course in science communication in Africa and also the first fully online course at Stellenbosch University. Since 2015, close to 200 delegates from across Africa and beyond have completed this course.

The challenges at the interface between science and society in South Africa, and the various role players that contribute to or shape science-society interactions, are the focus of this group's research programme.

By mapping research outputs in the field of science communication published

in major journals in the field over the last 30 years, the research team created a world map of science communication research that clearly illustrates the need to develop this field in Africa. The team also has a particular focus on people living in rural areas and townships in order to gain a better understanding of their perceptions and expectations of science. Furthermore, several research projects explore the roles of scientists in the public science communication ecosystem and the factors that influence their communication behaviour. In 2017, the group published a research paper on publicly visible scientists in South Africa which highlighted the need to support more women in science, particularly black female scientists, to become visible in the public sphere as opinion leaders and role models. The science-media interface including the impact of social media and issues of trust in science communication is another area of interest. Science public relation practices at research institutions and public trust in science will be key research focus areas from 2018 onwards.

#### SA RESEARCH CHAIR IN SCIENCE COMMUNICATION

Stellenbosch University hosts Africa's first research chair in the field of science communication, held by Prof Peter Weingart. This enables SU to develop this academic field across the continent and to provide new training and research niches for African students and scholars. The Chair's research will focus on the strategic value of science communication in contributing to a robust and resilient knowledge society where science plays a key role to improve people's lives and livelihoods. It is housed within the Centre for Research on Evaluation, Science and Technology (CREST).

# 75

## SEXUAL VIOLENCE

"If the recent #MeToo hashtag has taught us anything, it is that the prevalence of sexual violence against women is higher than society has ever dared to acknowledge. By prioritising sexual violence as a research field at SU, the University is increasing understanding of a phenomenon that negatively affects not only South Africa, nor only the African continent, but the entire world." These are the words of Dr Elisabet le Roux, research director of the Unit for Religion and Development Research.

The patriarchal gender constructs that dominate communities are conducive to sexual violence. If women are inherently valued less than men, and judged on their sexual purity or availability, sexual violence will remain endemic during armed conflict, but also in times of peace. Over the past ten years, Le Roux has been doing research on religion and gender-based violence, and specifically sexual violence, and how this interface plays out in communities affected by armed conflict. This research at community level has taken her to countries around the world, where she consistently saw how the sexual violence taking place during armed conflict is linked to how communities valued and judged women before war broke out.

Yet, sexual violence during conflict continues even when peace is officially established. One of the challenges remains the divide between the public and private sphere. "While we see the international community increasingly recognise and attempt to address the prevalence of sexual violence during armed conflict, sexual violence at household level receives little attention," says Le Roux. Research in the DRC has shown that the household remains the most dangerous space for women, even in a war zone.

Peace and reconciliation processes, so quick to address the structural factors that cause different factions to engage in armed conflict, fail to see and address how this violence continues to play out in interpersonal relationships, written violently on women's bodies.

In investigating sexual violence in conflict-affected settings, Le Roux's research also looks at the role of religion. She is involved in ongoing research projects that study religious responses to sexual violence in the DRC, Rwanda, Liberia, Uganda, South Africa and Colombia. Le Roux believes that religion, religious leaders, and religious groups can be crucial in addressing sexual violence, promoting gender equality and supporting survivors. "People of faith allow their religious leaders to influence their beliefs, values and behaviour. However, some religious leaders use their influence to promote interpretations of sacred scripture that are harmful to women," says Le Roux. "When they teach women to submit and suffer, or to prioritise their relationships above their personal safety, they are directly facilitating the continued perpetration of such violence. But irrespective of whether religion is a resource or roadblock, engaging with religion and religious leaders on sexual violence is a crucial part of community-based response to sexual violence.

"If you want to eradicate sexual violence at community-level, religious leaders have to be part of a holistic response strategy," emphasises Le Roux.

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## SHARKS

It took nearly six years, 5 000 pictures of the dorsal fins of great white sharks, and living at sea for up to two months at a time, for Dr Sara Andreotti and

her research team to complete the most comprehensive study to date on South Africa's great white sharks. In this study, researchers of the SU Department of Botany and Zoology not only sampled known free-ranging white sharks, but also built a database which links the genetic profile with the photographic identification of each individual shark. Fieldwork for the research – done in South Africa's shark mecca, Gansbaai, and along the rest of the country's coastline – used a mark-and-recapture technique to count the sharks.

The results from this part of the study indicate with 95% confidence a population estimate of between 353 and 522 individuals. According to Andreotti, this is 52% fewer than that estimated in previous mark-and-recapture studies. Andreotti is the main author of the article in the journal *Marine Ecology Progress Series* in which the findings of this study were published. Apart from the iconic status of these magnificent animals, the loss of such an apex predator will have a cascade of detrimental effects on the ecological stability of the marine environment of Gansbaai and the surrounding areas.

The first regional study concerning the population genetics of soupfin or tope sharks, copper or bronze whaler shark and the endemic lesser sandshark, found in South African waters, has recently been done by Dr Daphne Bitalo who received her PhD in Genetics from SU in March 2016. The research sheds light on how these species could be managed and fished sustainably. The study was performed in collaboration with the national Department of Agriculture, Forestry and Fisheries and the South African Shark Conservancy. Information about how each shark species' genetic make-up differs from region to region will help set out management units according to which better fisheries monitoring and specific conservation efforts can take place. The findings of this study could help to improve the regional management and conservation of commercial and recreational sharks.



## SHARKSAFE BARRIER™

The Sharksafe Barrier™ – a cost-effective and environmentally friendly alternative to conventional anti-shark devices was developed by a team of marine biologists comprising Dr Sara Andreotti and Prof Conrad Matthee of the SU Department of Botany and Zoology who collaborated with Dr Craig O' Connell (University of Massachusetts Dartmouth) and Michael Rutzen (white shark conservationist and shark cage diving operator).

This innovative structure is composed of an array of black plastic pipes deployed in the ocean to biomimic a kelp forest when viewed from within the water. The pipes are anchored to the sea-floor and are vertically buoyant. "Our work validates that kelp forests deter large predatory sharks and that they generally avoid swimming through them," explains Andreotti.

Furthermore, to enhance the effectiveness of the barrier, ceramic magnets are arranged along the length of the pipes forming the artificial kelp forest. Previous work showed that magnets deter shark species, including great white sharks, bull sharks, tiger sharks and hammerhead sharks.

The concept has been tested in Gansbaai, the mecca of South Africa's great white sharks. The research team built an underwater exclusion zone of 13 x 13 metres, and attracted sharks to the middle using bait. After 34 trials, and with 255 hours of video footage collected over a two-year period, not a single white shark entered the exclusion zone. Smaller fish, like skates, herring and mallets, did enter the exclusion zone and moved freely between the kelp-like structures.

The Sharksafe Barrier™ concept has been patented by SU, and has been accepted in Australia and Europe, with applications pending in Brazil, the USA and South Africa. The shark barrier end caps concept has been granted as a functional design in South Africa.

Andreotti says the technology addresses two major issues: the unjustified loss of human lives and the equally unjustified loss of marine life (whales, turtles, dolphins and sharks) due to the use of shark nets and drumlines: "Between 2011 and 2016 there have been 491 registered shark attacks worldwide, of which 43 proved to be fatal. Over the past 20 years, however, almost 4 000 sea creatures have been caught in shark nets lining the beaches of New South Wales in Australia alone."

Tourism is another important reason for protecting the world's great whites. In South Africa, the local white shark diving tourism industry is worth an estimated US\$4,4 million a year. According to Andreotti the temporary disappearance of white sharks in 2017 has already forced some of the cage diving companies to suspend their activities.



## SOCIAL INNOVATION

"SocioNovus is a social innovation initiative of Stellenbosch University. It engages with social innovation to deal with complex problems in society including poverty, inequality, unemployment, corruption, weak societal institutions and the leaders who lead these," says Prof Erwin Schwella, disruptive social innovator and entrepreneur at SocioNovus and professor at the SU School of Public Leadership.

SocioNovus initiates and facilitates knowledge-based inclusive social

SU researchers argue that assessment within teaching and learning places the onus on both teachers and learners to consider the practice as something done in association with others.

# TEACHING AND LEARNING <sup>[87][52]</sup>

innovation initiatives. They do this by using learning governance, learning leadership action research, and the action learning methods that they have developed. This learning is based on implementing prototype projects with and in communities that incorporates innovative and design thinking.

SocioNovus stimulates social entrepreneurship, which is defined as the innovative use of resources to explore and exploit opportunities that meet social needs in a sustainable manner. Social entrepreneurs are so-called change agents who serve large markets with limited resources as individuals and who are catalysts for social transformation. To this end social businesses are established, linking entrepreneurship with social purpose and profitable social business ventures. These social businesses create and distribute value effectively and ethically using entrepreneurship to create innovation and value and then share it equitably with all stakeholders.

Their proven ability since 2006 to create unique and innovative social business initiatives has earned SocioNovus the opportunity to share the current SU innovation space with Innovus.

Their success involves communities of expertise, referred to as thinking helixes, which create innovative solutions in the areas of governance for among others information and communications technology, infrastructure, water, energy, health, urban regeneration, education, safety and security. These thinking helixes are then connected to local and other government spaces of experimentation in social labs to test prototype partnership based projects.

The social labs, which are formally co-created with government and other partners including the private sector, civil society and the professions in a community, function as spaces to formally engage with SocioNovus to deliver a programme of social innovation interventions. Current social labs are at the Hessequa, Saldanha Bay, Prince Albert and Mosselbaai municipalities. More social labs will be established as the opportunities to do so arise.



## SOLAR ENERGY

While energy access is crucial for socio-economic development and well-being, the provision of affordable and clean energy is specifically listed as one of the United Nations' Sustainable Development Goals. "The globally-recognised energy research at SU is of utmost importance to develop appropriate technology and supporting mechanisms and institutions that address the challenges of the water-food-energy nexus, which is central to the notion of sustainable development," explains Prof Alan Brent of the SU Department of Industrial Engineering and the Centre for Renewable and Sustainable Energy Studies (CRSES).

This is well illustrated by a study that his Department undertook together with the CRSES to determine whether desalination technology, combined with a renewable source of energy is technically and economically feasible. While desalination can provide a sustainable supply of freshwater, these technologies are extremely energy intensive, and the use of large quantities of energy provided by Eskom is an unattractive solution. The study therefore investigated the use of solar energy and industrial waste heat to power seawater desalination for the supply of fresh water to a steel plant in Saldanha Bay.

It suggested improvements that could be made within the field of integrated solar energy, industrial waste heat and desalination technology in South Africa. "The sustainable solutions that such integrated systems offer, especially with the onset of climate change, make this especially relevant in water-scarce South Africa," says Brent.

The study was undertaken in collaboration with Geneva-based desalination technology developer Nereid Water and the multinational steel

### GEOSUN

GeoSUN Africa, a spin-off company of the CRSES, offers a variety of services relating to the solar energy industry, such as on-site solar resource measurements, bankable solar resource and yield reports, and other general supporting services and consulting to solar developers of large solar plants but also rooftop and stand-alone photovoltaic installations.

### STERG

The Solar Thermal Energy Research Group (STERG) has developed a unique South African concentrated solar plant technology, consisting of a field of tracking mirrors called heliostats and a small tower that captures concentrated sunlight capable of running a turbine at 1 000°C. The team won a grant from the Technology Innovation Agency to showcase the technology in a 100 kW pilot facility, which has since been constructed at Mariendahl, an experimental farm north of Stellenbosch.

### ROOFTOP SOLAR POWER

A study by CRSES investigated the implications of the use of rooftop solar power (PV) in a particular town in South Africa to determine the effect this may have on the municipal grid as well as the finances of the municipality. It was recommended that national technical standards that regulate rooftop PV installations should be finalised; additional incentives must be made available to improve financial viability; and that municipalities should lead by example and align itself with national and provincial government policy.

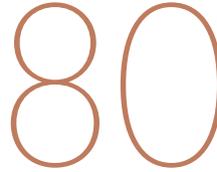
manufacturing corporation Arcelor Mittal. Nereid Water requires non-commercial type funding from sources such as the UN and the World Bank to demonstrate their desalination technology. In order to attract such funding, the use of a sustainable source of energy for at least a part of the desalination plant's energy requirements was stipulated. Being able to offset the huge freshwater demand of the steel plant using a partially solar-powered desalination plant provided the perfect opportunity to showcase the technical and economic feasibility of such technologies.

A solar heating for industrial process (SHIP) system was conceptualised, and for this evacuated tube and flat plate collector technologies were selected. Simulations based on the proposed SHIP system and the conditions in which the system would be implemented were done to determine the optimal type of solar collector to be used. Based on the approximate performance characteristics obtained from the simulations, economic analyses could be performed.

The analyses clearly displayed the financial viability of the proposed SHIP system, which led to the recommendation to increase the capacity of the desalination plant to meet all of Arcelor Mittal Saldanha Works' water demand. The economies of scale that could be realised, and the vast quantities of process waste heat available for use, justified the recommendation.

#### SCATEC SOLAR CHAIR IN PHOTOVOLTAIC (PV) SYSTEMS

The Chair held by Dr Arnold Rix, is supported by Norwegian global solar energy provider Scatec Solar – the first company to supply electricity to South Africa's national grid under the country's Renewable Energy Independent Power Producer Programme. It will enable SU to expand its role in renewable energy research focusing on optimising electricity generation from PV plants, and will provide support to the PV industry. The Chair will form partnerships with other research institutions in the general field of PV systems. The research programme is attracting top class students and has grown to more than 15 students in only three years.



## SKA

“The Square Kilometre Array (SKA) radio telescope and associated research chair provides an unparalleled opportunity for researchers and postgraduate students at SU to work very closely with one of the largest scientific engineering endeavours in the world,” says Prof Dirk de Villiers of SU Department of Electrical and Electronic Engineering. The SKA is soon to be known as Antenna Systems for SKA. De Villiers explains that his Department's long history of training microwave and radio frequency engineers ideally placed SU to take up the opportunity to be involved, and that this opportunity yielded an impressive amount of research outputs, graduate students and engineering prototypes. “We are especially proud of the graduates from this programme, several of whom have taken up positions within the South African SKA project, while many others are working all over the world at research centres, universities and private companies,” says De Villiers.

When South Africa received the nod from the international astronomy community in 2012 to host the major share of the SKA radio telescope, SU engineers also had reason to celebrate. Since the early 2000s they have worked closely with industry and the South African SKA project office on precursor technology such as the antenna system for the MeerKAT telescope, and to ensure that the Karoo site hosting the mammoth project is as ‘radio quiet’ as possible.

The Department's team of De Villiers, Prof David Davidson, Dr Gideon Wiid, Prof Howard Reader, Prof Petrie Meyer, Prof Matthys Botha, Dr Jacki Gilmore, Dr Danie Ludick, and their postdoctoral associates and postgraduate students, have been instrumental in this work.

“Our vision is to support the electromagnetic engineering in South Africa's SKA work as closely as possible, and to do world-class research at the same time,” states Davidson, who was awarded the SKA Research Chair in Electromagnetic Systems and EMI Mitigation in 2011. The Chair coordinates an extensive research programme on electromagnetic engineering, including work on the simulation and design of the antennas, radiofrequency front-ends (feeds and receivers), electromagnetic interference studies, and the characterising of the overall interferometric array. Davidson accepted a post at Curtin University in Australia in January 2018, and was replaced in the Chair by De Villiers.

“Designing the main reflecting dish and the feed for the SKA dish array is a demanding operation,” De Villiers explains his work on the MeerKAT and SKA reflector antennas done in collaboration with Stellenbosch Company EMSS Antennas. The dishes will last for many years, but the dish feeds will evolve to meet new science and technology requirements. De Villiers' research group, in collaboration with research groups in Sweden, Belgium and Iceland, are continually developing new and innovative methods and algorithms to design these very sensitive and high performance feed antennas more efficiently.

#### SA RESEARCH CHAIR IN ENGINEERING ELECTROMAGNETICS

This Chair held by Prof Dirk de Villiers entitled Electromagnetic Systems and Electromagnetic Interference Mitigation for the SKA, focuses on the electromagnetics underlying the design of antennas and radio frequency front-end systems. Projects include work on both the analogue front end and digital back end of radio telescopes, as well as electromagnetic interference mitigation (EMI) and work on appropriate enabling technologies.

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## SKELETAL MUSCLE

Skeletal muscle is essential for movement and hence good function of skeletal muscle is essential for quality of life. There are many conditions that can reduce muscle function, for example muscle injuries, aging-induced muscle atrophy or illness-induced loss of muscle mass, or muscle myopathies that could be inherited or acquired. “Nonetheless, skeletal muscle is a tissue that is rich in adult stem cells and highly capable of regeneration after injury or atrophy,” says Prof Kathy Myburgh, holder of the South African Research Chair in Integrative Skeletal Muscle Physiology, Biology and Biotechnology.

Physiology experiments are typically concerned with how muscle reacts functionally when it is still in the body (in vivo), when an experimental stressor or a potential treatment is applied. Myburgh’s Muscle Research Group (MRG) in the Department of Physiological Sciences focuses on adult stem cells that are called satellite cells inside and outside the body. Currently there are immunohistochemistry and microscopy techniques that can be used to assess these cells in biopsy sections: “Also, these satellite cells can be isolated from the muscle biopsies and encouraged to multiply in cell culture dishes,” explains Myburgh. A PhD student, Kiran Gudagudi, won second prize at the International Conference for Tissue Engineering and Regenerative Medicine when he presented their collaborative work on an index to assess primary human myoblasts’ ability to multiply outside the body (in vitro). “Cells of the immune system and connective tissue system also infiltrate damaged muscle to participate in the repair process by removing damaged muscle contractile proteins and providing

a temporary scaffold respectively,” says Myburgh. The fibroblasts may become over activated and result in fibrosis. The MRG is currently investigating potential treatments that would reduce the fibrotic response to injury. An MSc student, Tracey Ollewagen, won second prize at the Physiological Society of Southern Africa annual congress (2017) and now as a PhD student also an International Scholar travel award from the American College of Sports Medicine (2018) for this work. The research group is also investigating how gene therapy may help the regenerative process.

### SA RESEARCH CHAIR IN INTEGRATIVE SKELETAL MUSCLE PHYSIOLOGY, BIOLOGY AND BIOTECHNOLOGY

This Chair, held by Prof Kathy Myburgh and situated in the Department of Physiological Sciences, aims to close the gap between an in-depth understanding of the biological effects of trauma, inflammation and disease on skeletal muscle cells and the well-known ability of muscle to gain strength and regenerate from injury. Postgraduate students and postdoctoral fellows study these aspects of skeletal muscle at three complementary levels: whole body physiology (real humans), cellular and molecular biology (tissue and cells in culture dishes), and biotechnology (manipulation of regeneration). This multi-layered combination of expertise is unique in South Africa and uncommon worldwide.

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## SPECIES

After years of piecing together DNA clues and studying the most intense frequency of sonar calls of each of these flying mammals, scientists have described

### THE HYDRAPATCH

The reason one sweats with physical exercise is to get rid of excess heat generated by the inefficient process of skeletal muscle contraction and the conversion of carbohydrates and fats to energy for movement: “Like the engine of a car getting hot,” Prof Kathy Myburgh explains. In order to measure sweat rate during exercise, Myburgh and her postdoctoral fellow, Dr Filippo Macaluso set out to design a sweat patch that they have named a Hydrapatch, a market first. Three international patents have been granted, three others have been accepted and one patent is still pending for the Hydrapatch that can be worn on the arm.

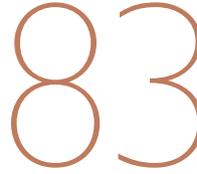
### SURPRISING DISCOVERIES ON ROBBERN ISLAND

Joint efforts by the SU Department of Conservation Ecology and Entomology and Robben Island management revealed some surprising discoveries. *Kurtguentheria macroxipha*, a very rare flightless mute cricket that was presumed extinct, was rediscovered in large numbers on Robben Island in 2010, the first year of this collaborative initiative. This discovery sparked much interest in the presumed depauperate biota of the island and, together with colleagues at the world-renowned Westerdijk Fungal Biodiversity Institute in the Netherlands, a survey of the fungi revealed seven new species. These included newly described genera such as *Paracladophialophora*, *Paracylindrocarpon*, and *Libertasomyces*. The latter was named for the freedom gained by all South Africans due to time that Madiba served behind bars on the island before the fall of apartheid.



four new species of horseshoe bats from east and southern Africa. The researchers compared key characteristics of the bats, including sonar calls, their skull shape, genitalia, and crucial divergence in DNA sequences to diagnose and classify the new species. The bat experts and evolutionary geneticists involved from SU's Department of Botany and Zoology were Dr Samantha Stoffberg and Dr Woody Cotterill, along with researchers from the universities of Venda, Swaziland, KwaZulu-Natal, and the University of Cambridge. The new species are Cohen's horseshoe bat, Smithers' horseshoe bat, the Mozambican horseshoe bat and the Mount Mabu horseshoe bat.

Prof Savel Daniels and co-workers from the SU Department of Botany and Zoology were joined in their research by one of the world's leading velvet worm experts, Prof Hilke Ruhberg of the Biozentrum Grindel und Zoologisches Museum in Germany, and have described 14 new velvet worm species from South Africa. The Onychopora, commonly known as velvet worms, are a charismatic group of invertebrates with a fossil record that is 550 million years old and belongs to a primitive euarthropod clade. Studies of the phylogenetic relationships of the group can provide insight into the evolution of segmentation and reproductive strategies in animals. In addition, since velvet worms are restricted to forests, phylogeographic studies of these species can provide valuable information on how the forest habitat in South Africa has contracted and expanded due to climatic changes. From a conservation perspective, research suggests high levels of localised species endemism indicating that habitat conservation management is critical for the survival of the group.



## SPORT DEVELOPMENT

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The Centre for Human Performance Sciences and Maties Sport collaborate on a variety of community sport development projects that include experiences with sport technology. The Centre takes an interdisciplinary approach to translational research and innovation in sport with specific responsibilities for expanding the academic footprint of Maties Sport.

The training of the coming generations of Maties Sport student athletes will draw increasingly from the application of new technologies. Helping primary and high school youth become accustomed to the interface between sport and technology will ease their transition should they aspire to serious sport training, and inform them about how technology can be used to measure and improve their sport performance. Under the leadership of Grant van Velden, manager of the Centre's Sport Technology Unit, sport technology sessions are included into the sport programmes presented by various Maties Sport clubs. Sessions focus on performance measurement, performance analysis and/or vision and decision training.

For talent identification programmes, laser-light timing instruments are often used because they allow the accurate measurement of speed as well as provide opportunities for aspiring athletes to measure their performance in terms of their personal best more precisely.

Analysing performance with the use of high speed movement cameras is not only fun, but assists coaches to help players to identify the strengths and weaknesses in their skill technique. In addition to teaching players how to capture the performance of a skill on video, they also can be taught how to use movement

analysis software. With these new skills, they can see the different patterns of offensive and defensive play used by their teams. GPS technology worn by players is another approach to performance analysis that is increasingly used.

Training for high performance sport involves a broad range of sport performance enhancement strategies, including specific activities designed to improve how athletes use their vision to make decisions about when playing their sport. The Centre presents high performance experience days for high school youth that provide them with opportunities to 'train like a Matie' with the Centre's vision and decision training technology.

The Institute of Sport and Exercise Medicine is attempting to reduce the risk of illness and injury in Maties athletes using the latest in online athlete monitoring systems, Smartabase. The Smartabase software is used by elite sports teams such as the Wallabies (Australian Rugby team), Liverpool Football Club (English Premier League) and the San Antonia Spurs (NBA League). Dr James Brown, postdoctoral research fellow at the SU Faculty of Medicine and Health Sciences explains: "In 2018, we plan to start monitoring rugby players and then expand this monitoring to all Maties athletes by the end of 2019. Eventually, this system will provide athletes, coaches, managers, medical staff and Maties Sport administrators with all the information they need on athletes including wellness, availability and performance metrics."



## SUBSTANCE ABUSE

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In most industrialised countries today, a woman can go through pregnancy and childbirth in the confident knowledge that the risk of death to herself or her

At SU, an extensive research programme is dedicated to the conservation of insects and their small allies; especially as South Africa is home to many thousands of species that occur here and nowhere else on Earth.



INSECTS [45]

baby, or even complications, is minimal and that dedicated specialists, technology and resources are available to take care of almost any eventuality. In the Western Cape Province however, this reality is very different, especially in poor communities where women are often caught up in a damaging cycle of disease, malnutrition and socio-economic ills such as excessive smoking and alcohol abuse.

Recognising the need to clarify the role of smoking and drinking in stillbirths and infant deaths, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institute on Alcohol Abuse and Alcoholism, and National Institute of Deafness and Other Communication Disorders established a cooperative agreement in 2003 for the Prenatal Alcohol in SIDS and Stillbirth Network to conduct the so-called safe passage study. Prof Hein Odendaal of the SU Department of Obstetrics and Gynaecology was the local principal investigator.

Between August 2007 and January 2015, a prospective cohort of 11 892 pregnancies representing 10 088 consenting and eligible women were enrolled. In South Africa, women were recruited from midwife obstetric units in two residential areas within Cape Town, and in the United States northern plains women were recruited from five clinical sites, including two American Indian Reservations.

Almost all (99,6%) of the 6 924 enrolled pregnancies in South Africa were women that self-reported coloured ancestry. Of particular concern are the high exposure rates among coloured women. Moderate/high levels of continuous smoking were found in 43% of pregnant women. High and low levels of continuous drinking were found in 18% of women. Many smoked and drank.

The study found that the dual exposure to smoking and drinking had significant effects on stillbirths and sudden infant deaths (SIDS). Combined drinking and smoking after the first trimester of pregnancy, compared with no exposure or quitting prior to the first trimester, was associated with an almost three times increased risk of stillbirth. It was also found that women with dual exposure had almost

12 times the risk for SIDS as compared to those with no exposure; and substantially higher risk than drinking or smoking alone. "This has important implications for the mothers' optimal behaviour in prenatal care, and provides important future research directions into how the toxins of alcohol and smoke interact to lead to sleep-related sudden death in a critical postnatal period," says Odendaal.

At present local data from the safe passage study are analysed to determine risk factors for placental insufficiency, poor foetal growth, placental abruption, preterm labour and the intrauterine diagnosis of foetal alcohol syndrome by ultrasound.

It was found that 10% of women used marijuana during pregnancy and 7% methamphetamine. The effects of these exposures on the outcome of pregnancy are being analysed.

According to Dr Annerine Roos of the SU Department of Psychiatry, there is a dearth of studies delineating the effects of maternal substance abuse on the brain structure and function in children. "Literature indicates that substance abuse during pregnancy is associated with adverse child outcomes, and we have an epidemic of preventable mental issues in offspring," says Roos. Recent studies therefore aim to clarify underlying neural impairment in order to guide interventions and inform preventative strategies. "The earlier, the better the outcome," Roos believes.

Longitudinal follow-up of children with prenatal methamphetamine or 'tik' exposure points to cognitive impairment that persists over time. There also appears to be differences over time in how brain networks develop and arrange themselves. For instance, segregation of principal regions is suboptimal in prenatal tik-exposed children compared to unexposed children. This likely affects cognitive competence and behaviour.

Findings on the early effects of prenatal alcohol exposure in neonates on structure and neural integrity, suggest suboptimal bottom-up development of the brain compared to unexposed controls. "This may relate to disrupted axon development and myelination," explains Roos. Brain network connectivity

was also investigated and there were early signs of functional disruption that suggests abnormal integration of functional networks even at this early age. Infants are currently being followed-up at two years of age using similar brain imaging techniques during natural sleep and developmental assessments.

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## SUGAR TAX

The global population is currently consuming more sugar than any other time in history, with sugary drinks increasingly becoming entrenched as part of our popular culture. Moreover, the South African government recently announced the introduction of a so-called sugar tax to counter excessive sugar intake by initially focusing on sugar-sweetened beverage (SSB) consumption.

In light of this, the research group of Prof Faadiel Essop of the SU Department of Physiological Sciences performed an analysis to review the links between sugar-sweetened beverage (SSB) intake and the risk for the development of cardiometabolic diseases. They began by critically evaluating clinical and epidemiological studies that were completed over the last decade. Their investigation revealed that – for most studies – SSB consumption increases the risk for the metabolic syndrome, diabetes and cardiovascular diseases onset. "Some studies found that that consuming as few as two servings of SSB a week was linked to such an increased risk, while others established that drinking at least one SSB per day was associated with elevated blood pressure," says Essop. Alarming, SSB consumption was associated with increased blood pressure values in adolescents. The team also argued that the sugar tax option should

be pursued in South Africa but together with well-designed, long-term studies to evaluate whether it will lead to decreased SSB intake and/or lower the prevalence of diabetes.

As the underlying mechanisms driving such processes are not entirely clear, Essop and the team established a unique pre-clinical model of long-term SSB consumption. Data revealed that the earliest SSB-mediated changes in the liver include higher oxidative stress and strain on the cell's ability to fold proteins correctly and led to their proposition that such SSB-mediated changes may in the long run contribute to the onset of decreased insulin signalling and trigger diabetes.

"As our study shows that increased SSB intake is robustly linked to the future onset of diabetes and hypertension, we propose the public should be made aware of this issue to a much greater extent. Here the focus should especially be on younger persons with the aim to induce longer-term behavioural changes," believes Essop.

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## SUPERLABS

Since 2013, South African scientists are on a par with their international peers with the completion of the first Trace Element and Experimental Biogeochemistry Clean Lab on the African continent at Stellenbosch University. With this facility, scientists are now able to participate in long-term international observational programmes such as GEOTRACES, which aims to improve the understanding of biogeochemical cycles and large-scale distribution of trace elements and their isotopes in all the major ocean basins over the next decade. Prof Alakendra Roychoudhury, head of the Department

of Earth Sciences and responsible for the lab, explains: "Our understanding of trace elements like iron and how it interacts with life in the oceans is surprisingly incomplete. We all know that iron is essential for phytoplankton growth and productivity, but we still need to understand how and in what form iron becomes available to phytoplankton. "Having access to this kind of facility also offers SU the opportunity to train and develop the next generation of scientists," he adds.

Stellenbosch University is also the first institution in South Africa to partner with Seeding Labs, an organisation that offers established researchers high quality affordable laboratory equipment and educational resources from leading universities and corporations. Seeding Labs also facilitate and establish meaningful connections with other scientists globally.

"The instrumentation we obtained from the Seeding Labs grant has proven invaluable in facilitating the training of our undergraduate and honours students over the last three years, and has also contributed to enhancing the productivity of several research groups," says Prof André de Villiers of the Department of Chemistry and Polymer Science. The instruments were installed in the analytical chemistry, inorganic chemistry and organic chemistry labs of the Department. They include two high-performance liquid chromatography instruments, one water purifier (Merck Millipore Elix® Water Purification System), two Buchi rotary evaporators, two high-precision balances and a variety of other lab equipment and instructional software for undergraduate use.

The Superconductivity Advanced Materials, Nanomaterials and Devices (SAND) laboratory in the SU Department of Electrical and Electronic Engineering further enables research projects that play a significant role in water purification, solar science and even the fruit industry. SAND research activities include the deposition of various materials onto membranes that assist with the self-cleaning of membranes under UV light, which means that they can be used for longer periods of time; manipulating small liquid droplets to

specific locations where analysis can be performed, specifically in medical diagnostics; generating power on a nanoscale with a nanogenerator that converts vibrations to electricity by using the piezoelectric effect; making organic solar cells more effective through research that focuses on using various methods and materials to improve solar cell efficiency; sensitising nanosensors through for example a surface acoustic wave (SAW) device that has been made to detect hazardous gases or particles; measuring fruit quality with Superconducting Quantum Interference Devices (SQUID) that make it possible to test for harvest readiness by doing non-destructive measurements of internal fruit quality, such as sweetness, or to screen fruit in packaging lines, and playing a part in space technology.

## SA RESEARCH CHAIR IN EXPERIMENTAL PETROLOGY

This Chair held by Prof Gary Stevens, studies the processes that shape the earth via experimentation on rock materials at the extremes of pressure and temperature found deep within the crust and mantle of the planet. The work is performed using a variety of special autoclaves in the experimental petrology laboratory in the Department of Earth Sciences, the only laboratory of this kind in Africa.

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## TEACHING AND LEARNING

"Research on teaching and learning encourages academics to locate their work within well-established theories of teaching and learning, and thus to be better informed about their own

approach to teaching. By providing opportunities for systematic reflection on teaching practices, research on teaching can significantly enhance student learning,” believes Prof Maureen Robinson, former Dean of the SU Faculty of Education.

All students who study to become teachers spend at least eight weeks a year in a school, where they observe practising teachers, teach their own lessons, and participate in school life. For some this is the highlight of their education programme as they become immersed in the realities and challenges of being a teacher. For others, this can be a stressful experience, as they may not receive the necessary mentoring and support that they need as beginner teachers.

Research commissioned by the Department of Higher Education and Training as part of a national strategy to improve the quality of education in the country, asked how schools and universities might cooperate better to fully support student teachers during the school-based component of their education programme. The team was led by Robinson and included Prof Peter Beets (now in the Western Cape Education Department), Prof Chris Reddy, Dr Linda Rutgers (now retired) and Dr Marie Louise Botha, all from the SU Department of Curriculum Studies, as well as two colleagues from the Cape Peninsula University of Technology.

School principals, teachers and university staff members, as well as members of national and provincial departments of education were interviewed in the Western Cape, Eastern Cape, Gauteng, Limpopo and KwaZulu-Natal. Overall, there was full agreement that schools and universities could improve their capacity to support student teachers. Certain conditions would however need to be in place for meaningful and mutual learning to occur: a good culture of teaching and learning, a caring and welcoming environment, and teachers who share knowledge and skills and who are willing to learn. Similarly, from the university side, there is a need for better communication with schools, more discussion about assessment criteria, and more discussion about

the purpose and design of the teacher education programme. Enablers and constraints pertaining to the above were identified and recommendations made.

Prof Nuraan Davids and Prof Yusef Waghid of the SU Department of Education Policy Studies look specifically at educational assessment in schools and universities in their book *Education, Assessment, and the Desire for Dissonance* (2017). The authors contend that it should be seen as a means through which teaching and learning can unfold and not just as something to test learners and students. The book covers themes such as the failure of governmental strategies for educational assessment; the power dimensions of pedagogic relations and assessment practices; the use of measurements and metrics in South African forms of assessment; and deliberative assessment encounters.

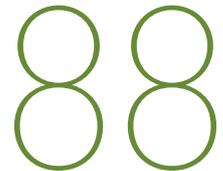
The authors looked at educational assessment practices in schools and universities broadly, while also drawing from South African experiences. Davids and Waghid say they wrote the book because they were concerned about South African schools and universities’ complacency and non-responsiveness to conceptions and practices of assessment. They argue that inasmuch as attempts have been made to move away from measurement and metrics, assessment in South Africa remains mostly connected to control and predictability, as commonly encountered in international trends in assessment.

“Assessment is overwhelmingly seen as something that has to be done in addition to teaching and learning. Such an understanding creates the impression that teaching and learning do not have an internal connection to assessment,” says Davids. “Educational assessment is constitutive of teaching and learning and not an add-on practice (a non-governmental practice), as is currently the case with assessment practices in South Africa.”

According to the authors, educational assessment aimed at improving teaching and learning can be successful if it also incorporates the idea that a learner or student should not necessarily accept a teacher’s particular assessment of his

or her work. “The student has to be allowed to disagree with the teacher (show dissonance/disagreement) – but, of course, has to show reasonable justification for doing so. In the same way, teachers cannot simply retreat into their rooms and assign marks/assessments to students without engaging with them.”

They propose an assessment within teaching as opposed to assessment of learning and an assessment for learning. “Assessment within teaching and learning places the onus on both teachers and learners or students to consider the practice as something done in association with others. Such a view is different from the traditional ones that prejudice doing things for others. This would mean that assessment ought to be considered as an encounter.”



## THE BRAIN

### OBSESSIONS AND COMPULSIONS

The MRC Unit on Risk and Resilience in Mental Disorders, which follows in the footsteps of the MRC Unit on Anxiety and Stress Disorders in the SU Department of Psychiatry, has continued with their strong focus on obsessive-compulsive and related disorders, and remains an established internationally recognised role-player in the field.

The work on obsessions and compulsions has rendered numerous publications in peer-reviewed scientific journals. These articles and chapters include clinical, genetics, neuropsychological and brain imaging data. In recent years MRI and genome-wide association studies in obsessive-compulsive disorder (OCD) and trichotillomania (TTM) have increasingly featured, with work contributing to several analyses.

The road ahead is exciting: several SU researchers are members of a five-country team that was granted funding for transnational research (SA, USA, Brazil, India, and the Netherlands). The goal of the project is to identify brain-based 'biosignatures' associated with cognitive and clinical profiles common in individuals with OCD that are reproducible across countries and cultures. Identifying brain signatures of measurable behaviours and clinical symptoms will likely provide robust new treatment targets. The Unit has also joined hands with several established international research sites in the USA to identify treatment targets across a variety of domains (neural, cognitive, molecular, endocrine, behavioural and environmental) to optimise pharmacological and behavioural interventions in TTM.

#### **SOCIAL ANXIETY DISORDER**

Social Anxiety Disorder (SAD) is characterised by excessive anxiety in social interactions. While scientists are beginning to understand how the brains of people with SAD process information during acute social stress, very little is known about resting brain conditions in the disorder and how these correlate with social behaviour. Recent studies performed in the SU Division of Nuclear Medicine, in collaboration with the MRC Unit on Risk and Resilience, have investigated regional glucose metabolism and resting brain networks in the disorder and how these measures are affected by moclobemide – an approved medication for the treatment of SAD.

This research has identified dysfunction in structures not conventionally implicated in anxiety, such as the cerebellum, and found that treatment resulted in increases in functional connectivity of the anterior cingulate cortex – a region recognised for its role in emotional processing. Another experiment used graph theory to demonstrate dysfunction within the Theory of Mind network and reported independent evidence of social cognitive bias in SAD, specifically how patients with SAD attribute socially relevant outcomes differently and how these biases are

affected by treatment. Experiments on how SAD sufferers' process emotional faces and monetary reward are ongoing.

#### **NEURONAL CELL DEATH**

The Neuro-Research-Group, headed up by Prof Ben Loos, focuses on the role of a key protein degradation pathway, autophagy, and its role in neuronal cell death. In particular, it is aimed to control autophagic activity with highest degree of precision, so as to assist in the clearance of toxic protein aggregates (amyloid-beta, p-Tau) associated with Alzheimer's disease or to cause neuronal cell death with unphysiological autophagy levels in aggressive brain cancer (gliomas). Autophagy has been recognised as a key pathway in cell death control. Neurons that are autophagy dysfunctional build up toxic proteins and die. The group uses various model systems to bring basic sciences closer to the bed side. The research conducted at SU has shown that precision-controlled autophagy can indeed direct cellular fate. A central tool is the use of molecular imaging, fully exploiting the power of fluorescence microscopy techniques. These include, in addition to traditional molecular techniques, super-resolution and recently also CLARITY, to visualise larger samples. "Neurodegenerative diseases and brain cancer contribute to the diseases of national priority, and are largely understudied in the South African research landscape. Novel treatment modalities are urgently needed," explains Loos.

#### **SARAH TUROFF ENDOWED CHAIR IN SCHIZOPHRENIA RESEARCH**

This Chair is situated in the Department of Psychiatry and held by Prof Robin Emsley. Brain diseases are major contributors to the disease burden globally and nationally and schizophrenia makes up a substantial component. It is a puzzling and complex disorder, impacting negatively upon individuals, families and society. The Chair will increase the visibility of schizophrenia research and enhance research opportunities for staff and students.

#### **SA RESEARCH CHAIR IN POSTTRAUMATIC STRESS DISORDER (PTSD)**

This Chair, held by Prof Soraya Seedat of the Department of Psychiatry, has a strong gene-brain-behaviour research focus, and aims to identify through state-of-the-art genetic and brain imaging methods the genetic, biological and environmental factors that contribute to increasing or decreasing a person's risk for developing PTSD once he or she has been exposed to trauma.



## **THOUGHTS ON SUSTAINABILITY**

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"Epidemiological modelling and analysis inform decision-making that improves public health. Good health for all is key to sustainable development because health affects everything we do – including our ability to learn, to work, and to care for others."

– Prof Juliet Pulliam, South African Centre for Epidemiological Modelling and Analysis

"Tensions between culture and rights often undermine women's equality. When we dissolve this tension and eliminate/revise harmful cultural practices women's freedom will contribute to sustainable development, especially when women live under customary law."

– Prof Amanda Gouws, SA Research Chair in Gender Politics

"Social-ecological resilience is emerging as a key approach to addressing the UN's sustainable development goals, by uncovering the connections and interactions between the social and ecological challenges we face, and how these can be practically addressed

# THE BRAIN [88][67]

The research conducted at SU has shown that precision-controlled autophagy can indeed direct cellular fate. A central tool is the use of molecular imaging, fully exploiting the power of fluorescence microscopy techniques.

in the context of an increasingly turbulent world.”

– Prof Oonsie Biggs, SA Research Chair in Social-Ecological Systems and Resilience

“Environmental sustainability is a core value of the South African wine industry, and some of the key initiatives include to maintain regional biodiversity, to work with – and not against – the natural environment and to reduce technological interventions. However, the alignment of environmental sustainability with economic sustainability remains a huge global challenge and we focus on evaluating and investigating the complex natural microbial biodiversity that dominates the wine environment, on understanding the relevant ecosystem dynamics and on innovative solutions on how to integrate and exploit this natural biodiversity in the wine making process.”

– Prof Florian Bauer, SA Research Chair in Integrated Wine Sciences

“Ecological overshoot has been accelerating across the globe. Optimising biocapacity has become a key to resolve the overshoot of ecological demand in regional sustainable development. However, most literature has focused on reducing ecological footprint but ignores the potential of spatial optimisation of biocapacity through regional planning of land use.”

– Prof Cang Hui, SA Research Chair in Mathematical and Theoretical Physical Biosciences

“Sustainable practices in pavement engineering of the 21st century equate to a shift away from mining non-renewable resources, towards the harvesting of under-utilised and often squandered resources such as recycled road layers and construction-demolition materials.”

– Prof Kim Jenkins, SANRAL Chair in Pavement Engineering

“We need to understand what sustainable development means across different scales and for different constituencies. Although often presented as embracing a set of goals that everyone can readily agree on, sustainable development is not a politically neutral construct; both

priorities and the processes of advancing them can be deeply contested.”

– Prof Cherryl Walker, SA Research Chair in the Sociology of Land, Environment and Sustainable Development

“With over 30% of food production lost and wasted before they reach the consumer, saving the harvest through application of novel postharvest technologies should be part of our sustainable food system.”

– Prof Linus Opara, SA Research Chair in Postharvest Technology

“The PRASA Engineering Research Chair strives to convert academic research into practical applications in support of PRASA’s mission to become a modern public entity capable of delivering high quality passenger rail services on a sustainable basis.”

– Prof Neels Fourie, PRASA Engineering Research Chair

“By impacting positively on health, one of the cornerstones of sustainable development, the CBTRB contributes towards a number of other goals, such as poverty reduction, economic growth and through our global links, towards partnerships to achieve these goals.”

– Prof Paul van Helden, DST-NRF Centre of Excellence for Biomedical TB Research

their vision to provide a platform for the development of innovative and cost-effective intelligent transport system solutions.

Research at the SSML is refined to four key areas that include Smart City, Mobility as a Service (MaaS) and Connected /Autonomous Vehicles (CA/AV). The SSML aims to be a data hub for both static and real-time transportation data, focusing on the Stellenbosch area. The SSML data sources are being developed to include floating car data, traffic camera input, traffic detector data, freight transport information, and data from specifically positioned detectors.

The SSML supports the notion to make Stellenbosch the first true ‘Smart City’ in South Africa. A Smart City uses data, information technology and communications to optimise infrastructure usage and improve service efficiency. Part of this initiative will include a real-world test of dynamically managed traffic signals along the R44 corridor to optimise traffic flow. Parking management clusters have also been identified as a means of facilitating real-time congestion reduction in inner Stellenbosch.

Improvements to congestion in the Stellenbosch town centre and arterial road network will also be unlocked through the use of new mobility solutions, such as MaaS. Non-motorised transport, ride-share and integrated public transport, and the autonomous vehicle environment are being investigated on the SU campus, and the CV/AV movement is particularly considered with reference to the developing country context.

### **SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED (SANRAL) CHAIR IN PAVEMENT ENGINEERING**

The SANRAL Chair in Pavement Engineering is located in the Geotechnical and Transportation Division of the Department of Civil Engineering. The incumbent of this Chair (which is sponsored by the National Roads Agency), Prof Kim Jenkins, carries out his research within the Institute for Transport Technology. The primary objective of the SANRAL Chair is to develop human capital and technology in Pavement Engineering. The research



## **TRANSPORT**

The significant transport issues and ideal test-bed conditions of the town of Stellenbosch are the reasons that the Stellenbosch Smart Mobility Laboratory (SSML) was established at the SU Department of Civil Engineering in 2014. The SSML aims to address transport issues in Stellenbosch while fulfilling



### UNDERSTANDING THE LOGISTICS AND SPEEDING PATTERNS EVIDENT IN THE TAXI SECTOR

A study by master's student Nelson Ebot Eno Akpa, Prof Thinus Booysen (both from the SU Department of Electronic Engineering) and Prof Marion Sinclair of the SU Department of Civil Engineering, focused on speed compliance of long-distance minibus taxis between Cape Town and the Eastern Cape. They set out to understand the logistics and speeding patterns evident in this sector. Ten taxis from Stellenbosch were equipped with GPS tracking devices sponsored and installed by MiX Telematics. This enabled the remote monitoring of the position and speed of the vehicles. Interventions and incentives that should improve speed compliance were also investigated, such as average speed enforcement (ASE), audible speed warning tones, and the inherent reduction in fuel expenses from driving slower. Analysis of the speeding patterns and subsequent interviews showed that little understanding exists about ASE and that it did not seem to have the desired effect. As an alternative intervention, a loud speed-triggered buzzer was remotely activated and tested at two volumes. The impact of the audible warning tone was stark: with the loud activation, the mean speeds of the 20 trips completed were below 120 km/h, and only 40% above 110 km/h. Time-based speeding frequency dropped from 81% to 60%. The soft tone also resulted in a significant reduction in speeding frequency (70%).

group has active international collaboration with the Technische Universiteit Delft (Netherlands) and Wuhan University (China), amongst others. To achieve advanced development of skills in pavement technology, the Chair offers specialised postgraduate courses to students and practitioners in the roads industry to keep them abreast of new global developments. This knowledge is expanded into research in the Department of Civil Engineering that investigates new material technologies, from nano to macro level. It also includes performance material performance analysis and design models, which are taken to advanced levels with numerical modelling. In particular, sustainable road practices are advanced through research into pavement rehabilitation that includes road recycling, sustainable materials usage and construction practices.

### NATIONAL AEROSPACE CENTRE (NAC) RESEARCH CHAIR IN AERONAUTICAL DYNAMICS AND CONTROL

The goal of this Chair held by Dr Japie Engelbrecht and situated in the Department of Electrical and Electronic Engineering, is to promote the development of skills and technology in automatic flight control of aircraft for the benefit of the South African aerospace industry. The research group performs research on the flight control of aircraft ranging from unmanned aerial vehicles to large passenger airliners.

### PRASA ENGINEERING RESEARCH CHAIR

The research focus of the Passenger Rail Agency of South Africa (PRASA) Engineering Research Chair held by Prof Neels Fourie and situated in the Department of Industrial Engineering, is the improvement of operational activities of PRASA, with specific focus on engineering solutions, maintenance and operations management, systems engineering, reliability improvement, supply chain management, modelling and simulation, finite element modelling, material conformance testing and regenerative power. The Chair ensures that strategic decisions of PRASA are

supported by a sound corporate baseline which is founded on scientific merit, with regular operational analyses of efficiency and effectiveness. The ultimate aim of the Chair is to improve passenger experience using rail transport on a daily basis.

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## TRANSPLANTS

In December 2014, a medical team from SU and Tygerberg Hospital made history when they performed the world's first successful penis transplant. Prof André van der Merwe, head of the SU Division of Urology, led the marathon nine-hour operation. The 21-year-old recipient had lost his penis three years earlier from complications after a traditional circumcision. More than three years later the patient is doing extremely well, both physically and mentally. "He is living a normal life. His urinary and sexual functions have returned to normal, and he has virtually forgotten that he had a transplant," Van der Merwe said.

In April 2017, Van der Merwe and his team performed a second penis transplant, making it the first medical centre in the world to successfully perform this procedure twice. The recipient was a 40-year-old male who had lost his penis 17 years before, also due to complications after a traditional circumcision.

Penile mutilation is more common in South Africa than elsewhere in the world due to complications of circumcisions performed as part of a traditional rite of passage on young men in certain cultures. Experts estimate that as many as 250 partial and total amputations take place country-wide every year, with suicides also being reported. "At Stellenbosch University and Tygerberg Hospital we are committed to finding cost-effective solutions to help these men," says Van der Merwe.

These procedures were part of a proof of concept study to develop a cost-effective penile transplant procedure that could be performed in a typical theatre setting in a South African public sector hospital. By applying lessons learnt from the first transplant, Van der Merwe and his team were able to significantly cut the costs of the second procedure.

“The success of this procedure in the hands of our transplant team is testimony to the high level of skill and expertise that exists in the public health sector in South Africa,” said Prof Jimmy Volmink, Dean of SU’s Faculty of Medicine and Health Sciences. “Also of considerable pride is the team’s ability to balance compassionate and ethical patient care on the one hand, with a concern for the efficient use of scarce resources on the other.”

According to Dr Amir Zarrabi of SU’s Division of Urology and a member of the transplant team, patients describe a penis transplant as ‘receiving a new life’. “For these men the penis defines manhood and the loss of this organ causes tremendous emotional and psychological distress.”

A penis transplant is a complex procedure known as a composite tissue transplant, during which different types of tissue are cross-connected between the recipient and the donor organ. The surgeons connected three blood vessels (each between 1 and 2 mm in diameter) to ensure sufficient blood flow to the transplanted organ; two dorsal nerves (also between 1 and 2 mm in diameter) to restore sensation; the urethra, which enables the recipient to urinate through the penis; as well as the cavernous body of the penis, which will allow the patient to obtain an erection.

“The diverse presentation of the blood vessels and nerves makes the operation very challenging and means each case is unique. All these structures need to be treated with the utmost delicacy and respect in order to be connected perfectly to ensure good circulation and function in the long term,” said Dr Alexander Zülke of SU’s Division of Plastic and Reconstructive Surgery.

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## TREATMENT BARRIERS

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Since 2015, Prof Ashraf Kagee and Dr Bronwyne Coetzee of the of the SU Department of Psychology have been collaborating with colleagues in New Zealand to explore the feasibility of a visual model to improve medication adherence amongst adolescents and adults receiving antiretroviral therapy (ART).

This work stems from their previous research on treatment barriers and recognises that in order to overcome individual level treatment barriers (such as missed doses, and treatment fatigue) patients need to be provided with information, motivation as well as skills required to take their medication in the proper way. This visual model is also being piloted amongst caregivers to children under five years of age who are receiving ART.

“The rate of new HIV infections in South Africa is still unacceptably high,” says Coetzee. She adds that while more people than ever are receiving antiretroviral therapy in South Africa, stable access and adherence to treatment remains challenged by individual and structural barriers. Coetzee’s research is becoming increasingly focused on supporting caregivers of young HIV-infected children to mitigate treatment barriers at an individual and household level, but adds that research is needed to support healthcare workers in finding appropriate and manageable ways to assist their patients with difficulties they experience accessing ART. Coetzee also says that there is a need to explore treatment barriers among children and adolescents living with disabilities, in both rural as well as densely populated urban areas.

Kagee’s research has shown that many structural barriers to ART adherence persist, such as HIV-related stigma, hospital overcrowding, food insecurity, migration, the influence of charismatic religious leaders who discourage patients from taking their medication, as well as insufficient psychosocial support for patients. In addition, common mental disorders, especially depression, anxiety, and alcohol use are barriers to optimal ART adherence. He is currently working with colleagues at UCT, Massachusetts General Hospital and the University of Miami to test a nurse-delivered psychological treatment to reduce depression and enhance ART adherence.

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## TUBERCULOSIS (TB)

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To achieve TB control, it is critical that basic research synergises with practices in the healthcare facilities. There are few places in the world where there are such rich opportunities to do exactly this type of cross-cutting TB research as South Africa. At SU, a team of world-leading scientists undertake research on a wide range of TB-related questions, spanning disciplines including host genetics, immunology, bacteriology and clinical testing of new drugs and diagnostics. This microcosm of TB research affords many opportunities for multi-disciplinary national and international collaborations, a cornerstone of successful TB research.

Health-related quality of life (HRQOL) and adherence to treatment are two often inter-related concepts that have implications for patient management and care. Dr Tanja Kastien-Hilka addressed this question in her PhD project, in cooperation with the Swiss Tropical and Public Health Institute, the

University of Basel, the Health Economics Unit at the Faculty of Health Sciences of the University of Cape Town and the Division of Clinical Pharmacology at the SU Faculty of Medicine and Health Sciences.

The study showed that TB has a clear negative impact on the quality of life, with specific impairments in physical, mental and psycho-social health. Not only the typical symptoms such as coughing, fever, and weight loss caused by TB affected the HRQOL negatively, but also mental and psycho-social aspects, such as anxiety, depression, social stigmatisation and feeling isolated. TB treatment significantly improved quality of life of the patients.

The results of the study allow planning of proper future studies to estimate the success of a certain treatment, taking into account not only the time to cure, but also the quality of life during and after the treatment phase. "In essence, the study showed that health-related quality of life improved over a six-month treatment period. It was concluded that – not surprisingly – management of TB patients should, besides adequate drug treatment, address their specific mental and psychosocial needs," says Prof Bernd Rosenkranz of the SU Division of Clinical Pharmacology.

According to Prof Gerhard Walzl of the Department of Molecular Biology and Human Genetics, the challenges in tackling the disease include the facts that people are tested too late and that the turnaround for most tests is long. To remedy this, a point-of-care rapid diagnostic test for TB has been developed by a multinational team of scientists led by researchers at Stellenbosch University. The low-cost screening test has the potential to significantly speed up TB diagnosis in resource-limited settings. If the test is accepted after clinical trials are completed it will be able to provide almost immediate results. People will be able to be diagnosed and start treatment in a single visit to a healthcare facility. The test's accuracy and efficacy will be tested in five African countries. "We will recruit 800 people who have TB symptoms from Namibia, the Gambia, Uganda, Ethiopia and South Africa," explains Walzl. Clinical research sites will be set up or

strengthened in all five countries, and participating countries will be able to use the data generated from this project.

A promising new drug for the treatment of multi-drug resistant (MDR) TB has been conditionally approved by the European Medicines Agency. The drug, elamanid, was developed by the Japanese pharmaceutical company Otsuka, and was tested by TASK Applied Science, a clinical trials unit founded and run by Prof Andreas Diacon at SU's Faculty of Medicine and Health Sciences. "We were the first worldwide to give delamanid to a TB patient, and we also published the first report on the use of delamanid in TB patients," said TASK director, Dr Florian von Groote-Bidlingmaier, a specialist physician in the SU Division of Internal Medicine and Pulmonology who is responsible for the MDR-TB trials at Brooklyn Chest Hospital.

#### SA RESEARCH CHAIR IN MYCOBACTERIOMICS

The research aim of this Chair held by Prof Samantha Sampson, is to perform in-depth characterisation of clinical strains of *M. tuberculosis* and other mycobacterial species isolated from humans and animals on the African continent. Knowledge gained will support the goal of an improved understanding of mycobacterial biology aiding the design of effective tuberculosis vaccines, diagnostics and therapeutics.

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## TUBERCULOSIS IN CHILDREN

Long treatment regimens, bitter-tasting adult-size tablets and painful injections with serious side effects are some of the challenges researchers at Stellenbosch

University are tackling in order to try and ease the treatment of children with TB, including drug-resistant TB. There is also a strong focus on the prevention of both drug-susceptible and drug-resistant TB in children, given the dramatic burden TB imposes on children and families.

"We can cure children with TB, but the challenge is to make the treatments more child and family friendly by shortening the regimen and giving children medications that are easy to swallow," says Prof Anneke Hesselning, director of the Desmond Tutu TB Centre (DTTC), Department of Paediatrics and Child Health at SU's Faculty of Medicine and Health Sciences, whose team is doing pioneering research aimed at addressing the challenges of paediatric TB. The DTTC is part of the first ever trials of new TB drugs (delamanid and bedaquiline) in children and their research for delamanid has already helped to identify the paediatric dosing and show its safety in children six years and older, which has led to the WHO recommending its use in children.

Hesselning's research group is testing new treatment strategies to shorten the treatment regimen for drug-sensitive TB from six to four months for children with non-severe forms of the disease, and they hope to shorten the treatment for multi-drug resistant TB (a strain of TB resistant to most first-line drugs) from the current 9-12 months, to six months, and also do away with older toxic drugs, including the six-months daily injections which can lead to permanent hearing loss. About one in 20 children who develop TB in South Africa, gets multi-drug-resistant TB.

#### SA RESEARCH CHAIR IN PAEDIATRIC TUBERCULOSIS (TB)

This Chair, held by Prof Anneke Hesselning of the DTTC focuses on the evaluation of improved and safe TB preventive and treatment strategies in HIV-infected and uninfected children. Evaluation of novel drug regimens for MDR-TB prevention and treatment is a key priority. Other research focus areas include the improved TB diagnosis in children including novel diagnostics and biomarkers, the evaluation of new TB vaccine strategies, and implementation science research to improve the care, recording and reporting of TB in children.

# PROTEAS [66][7]

Leaf blackening is a postharvest disorder that inhibits protea exports; research at SU suggests that the right sugars at the right time can improve the quality and vase life of these iconic South African flowers.

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## VACCINES

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“Vaccinated, healthy children can go to school and grow up to become productive adults, and parents can work instead of caring for sick children. Therefore, our work on early childhood vaccination at Stellenbosch University has a direct impact on reducing poverty in our communities,” says Prof Charles Wiysonge, director of the South African Cochrane Centre of the South African Medical Research Council.

While vaccination is proven to be a cost-effective way of reducing child mortality, not enough children are vaccinated, especially in sub-Saharan Africa and in low and middle-income settings.

Globally, a wide range of communication interventions to improve vaccination has been developed and evaluated, but this disparate evidence is not available in such a manner that it can inform decision-making.

It is also not clear to what extent these interventions address existing barriers to vaccination. As there has not been any comprehensive approach to organising the broad range of possible communication interventions, the systematic mapping of the evidence could provide a clear means to identify the scope of available interventions and their effectiveness, assess where evidence gaps exist, and determine ways to plan future vaccination programmes.

Charles Wiysonge and his team from the Centre for Evidence-based Health Care at SU designed a mixed-methods study with six components to address this evidence gap. This was done in collaboration with the Centre for Informed Health Choices at the Norwegian Institute of Public Health and other institutions in Europe, Africa, and Australia. They did a scoping review of provider-parent communication

interventions for childhood vaccinations by searching, screening and extracting data from relevant literature, and developed taxonomy of interventions. The evidence map and taxonomy were presented to multiple immunisation stakeholders to identify high-priority topics for systematic reviews of interventions.

Systematic reviews and primary research conducted as part of this project formed the basis of guidance on communication interventions to inform and educate caregivers on early childhood vaccination in the World Health Organization (WHO) African Region; which were adopted at the WHO Guideline Development Group meeting held in February 2018 in Pretoria.

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## VISUAL REDRESS

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Visual redress is an attempt to right the wrongs of previous and current powers by removing hurtful symbols of apartheid, social injustice and misrecognition, and remedying the harm that has been caused by these visual symbols by compensation through new visual symbols. “Policies for higher education institutions show great progress towards transformation, but transformation of physical spaces has been slow. Attempts at promoting transformation therefore require moving beyond policy to practical projects within higher education contexts. These projects include visual redress projects on campus spaces,” explains Prof Elmarie Costandius, senior lecturer in the Department of Visual Arts.

The traces of colonialism and apartheid are still deeply embedded in South Africa, and this is reflected in its higher education institutions. Stellenbosch University, in particular, has a history that is strongly tied to the Afrikaans language

and culture. One example of this is evident in the overwhelming majority of the buildings and signage on campus still only identified and presented in Afrikaans. Another is the lack of historically diverse and inclusive statues or artwork on the main campus.

Research over the last four years by the Department of Visual Arts, has suggested a need for more extensive and engaged discussion with all stakeholders on campus as the first necessary step in addressing and then transforming the aesthetics (and hence politics) of the shared space of the Stellenbosch University campus. Furthermore, rather than respond to the issue of visual redress on campus by replacing old statues with new ones, a more dynamic, inclusive and visual project is proposed that would form part of a larger five-year plan with the aims to maintain and develop a public conversation around decolonisation on campus; work towards more permanent structures/installations and changes in the visual language of the campus; and contribute towards the integration of social, academic (curricula) and cultural transformation on campus.

The SU role players should therefore comprehend the relationship between the coloniser and colonised. Research has shown that white, privileged students and lecturers tend to experience the campus culture of historically white universities, such as Stellenbosch University, as natural and they feel at home while black and/or disadvantaged students and lecturers tend to find this culture discomfiting, alienating, disempowering and exclusionary.

This project follows the draft revised White Paper on Arts, Culture and Heritage’s urge to the decolonialise South Africa’s social and cultural spaces, and recognises that the theme of decolonising space on the university campus is one that will invite varying intensities of interest – from activism to curiosity to distance and fear. “We would like to utilise the critical and social potential of the arts to probe these issues in an open-ended way – to create the scaffolding for students explore issues of racial discrimination, social justice, hegemony, exclusion, cultural expression, history,

pain and identity (amongst others) with their peers and fellow campus members through creative student projects,” explains Costandius.

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## VULNERABLE COMMUNITIES

In a country where violent crime has become part of the norm, where rape and sexual assault is reported to be of the highest in the world and where many South Africans live in abject poverty, social workers have become foot soldiers combatting the social issues that arise from these societal problems. For Prof Lambert Engelbrecht of the SU Department of Social Work, social workers are essential in the fight to protect the most vulnerable in society. But, while this is the case, their quest is not easy as many have to work in a system that does not provide the resources needed to make the necessary impact.

This is something that Engelbrecht has seen in his own research over the years. His research was inspired by the realisation that ironically the individual was often overlooked in the social work environment. A recent example of such a case, still fresh in the memories of many South Africans, led to the death of at least 143 vulnerable patients who were moved from Life Esidimeni, a state-run facility, to a number of NGOs that were ill prepared to accommodate these patients.

“This is an example of how the Minister of Health tried to cut spending but ended up doing so at the expense of the end user.” Engelbrecht believes that the dehumanisation of vulnerable persons for the sake of financial sustainability showed that what may be considered to be better management principles that

would lead to better services is often not what transpires in reality. “Saving on costs is not always better for the client. This is why I empathise with the protest marches by social workers in 2017 against the working conditions they are exposed to. There are many social workers with no access to telephones, computers or cars that are expected to deliver social services to the most vulnerable in our society.”

Engelbrecht, who received the Stals Prize for Social Work from the South African Academy for Science and Arts in June 2017, spends most his time focusing on the supervision and management of social workers and the training of social work students. Engelbrecht and his colleagues focus on equipping students to think holistically. “In order to be prepared for what they will face in the field, we have to teach our students to think beyond assisting the most vulnerable or those with mental health issues, but to start looking at the structures within which they work. This involves understanding the issues that impact on your work, and being able to engage with government at local and national level to bring about change.”

At SU, about 100 new students register for a degree in social work each year with about 300 undergraduate and postgraduate students studying at the Department at any given time. In 2017, these students rendered social work services as part of their practice education to 43 welfare organisations where they were supervised by 45 social workers. They were involved in 94 community projects, facilitated 197 small groups, were also involved in intervention to 579 families and individuals, and mentored 90 vulnerable children. In addition the students completed 57 research projects.

“The students are being prepared to the deal with the realities of South African society. They are confronted with both academic expectations and with emotional challenges that other students are not necessarily facing,” maintains Engelbrecht.

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## WASTEWATER

An EU-funded project of which Stellenbosch University is an African academic partner, is aiming to find a solution to a challenge that is faced by some 108 million people in Africa: access to clean water. The project represents a consortium of European partners from Germany, Italy and Spain providing European know-how on new technologies for water purification with local input by countries such as South Africa and Mozambique. The aim is to research and develop an autonomous ‘made in Africa’ water treatment system that can efficiently degrade harmful pollutants while killing microbiological contaminants, and which is accepted by rural communities

Closer to home, new, so-called water fingerprinting technology is tested in Stellenbosch in collaboration with organisations such as East Rand Water Care Company, Stellenbosch River Collaborative and Enkanini Research Centre. In this internationally collaborative project, researchers are developing a real-time community-wide public health early warning system (EWS) by measuring biomarkers – molecules made by the body that characterise disease and illness – in the sewage system. “Urban water contains a mixture of human waste, wastewater and run-off samples, pooled from contributing populations,” explains team member Prof Gideon Wolvaardt from the SU Department of Microbiology and director of the SU Water Institute. “To epidemiologists, this cocktail contains a treasure trove of information on the underlying health status of the population and surrounding environment.”

Developed by interdisciplinary experts from the University of Bath and Stellenbosch University, the technology to test a city’s water could mitigate infectious disease, limit the spread of antibiotic

## HOW TO TREAT WINERY WASTEWATER

A PhD study by Danielle de Beer of the SU Department of Microbiology on the treatment of nutrient-rich wastewater from wineries resulted into treatment technology that has been patented and licenced, and is being released commercially. Releasing untreated winery wastewater can cause eutrophication and toxicity in surface water with detrimental effects on soil condition and ground water quality. In an effort to address this issue, De Beer designed and tested an energy-efficient pilot-scale biofilm reactor with a small footprint for winery wastewater treatment at a Stellenbosch winery. It showed effective, robust treatment of winery wastewater of varying strengths with minimal solid waste production, and performed at its peak when treating highly concentrated wastewater during harvest season. The pH of treated wastewater was also consistently buffered and remained close to neutral.

## INVESTIGATING THE TREATMENT OF ACID-MINE WASTEWATER

Dr Rehana Malgas-Enus of the SU Department of Chemistry and Polymer Science reports that her research group investigates the use of superparamagnetic nanoparticles for the treatment of acid-mine wastewater. "The recovery of dissolved precious metals such as gold, platinum and palladium is of great interest, and finding an effective and economical way to recover these precious metals from industrial effluents is crucial," says Malgas-Enus. "These metals have a tendency to adsorb onto the surface of 'naked' and modified superparamagnetic nanoparticles, making extraction fast and efficient. The magnetic nature of these nanoparticles allows for easy separation of the loaded nanoparticles from the wastewater and enables us to recycle the nanoparticles, which lowers the costs."

resistant 'superbugs' such as *E. coli*, and enable authorities to monitor the overall health of the public. The project will use Stellenbosch as a case study to test the feasibility of implementing a EWS in South Africa and in other low and middle income countries across the world.

State-of-the-art chemistry, genetics and electronics methodologies will be applied to unlock this information and provide real-time health profiles of urban water samples. This will enable government health professionals to identify risks to public health and mitigate potential widespread crises such as pandemics and infectious diseases. "South Africa, where 65% of the population live in urban settings and is predicted to grow to 80% by 2050, provides a good representation of the alarming rate of urbanisation that often exceeds the rate at which additional medical care can be introduced. Community-wide surveillance can thus become a powerful first line of defence in health care, and the experience gained here can be transferred to other countries," maintains Wolfaardt.

## STELLENBOSCH UNIVERSITY WATER INSTITUTE (SUWI)

SUWI functions across various SU faculties and includes topics such as the ethics of freshwater management, ownership of water, the safety of agricultural produce, biofouling and biocorrosion control, community health, financial-economic planning of water use, filtration, endocrine disruptors, hydrodynamics, water engineering, catchment and resource management, invasion biology, the geochemical evolution of water and waste waters, and water governance and management.

## ERWAT RESEARCH CHAIR IN WASTEWATER MANAGEMENT

The Stellenbosch University Water Institute hosts the ERWAT Chair in Wastewater Management held by Prof Gideon Wolfaardt. The goal of this five-year research programme, which started in 2013, is to foster partnerships in water research utilisation and training. This Chair presents the opportunity to work towards scientific and technical advances against the backdrop of environmental and socio-economic realities.



## WINE

Wine is an unusual agricultural consumer product: a lifestyle and frequently perceived as a luxury product, subjected to strong fluctuation of total output and consumer attitudes. An analysis of cycles in wine production over time can teach us much about the status of the industry, believes Prof Nick Vink from the Department of Agricultural Economics. "In this respect, researchers at SU have been involved in a global study of wine cycles in all countries that produce wine, to try and identify what drives these cycles. In South Africa, it is clear that domestic consumption has not been enough to drive production, and that the industry depends on exports for its growth," says Vink.

To better understand the local market, and in line with a greater international focus on scientifically evaluating the opinions and perceptions of consumers, a recent PhD study by Dr Carla Weightman (Institute for Wine Biotechnology) and supervised by Dr Helene Nieuwoudt and Prof Florian Bauer, obtained a better cross-cultural understanding of South African wine consumers. The study focused on consumers' relationships with wine, as well as the aspects affecting their purchase decisions. Weightman explored wine style preferences, occasions for enjoyment, purchase and consumption patterns and journeys towards wine consumption. It is evident from this research that consumers have varying relationships with wine. Gender, and, perhaps surprisingly, not cultural background, is the biggest divider in consumers: in general, the social and emotional connection to wine is more important to female consumers, while for male consumers wine is seen as a symbol

### ANALYSING THE WINESCAPE

Prof Sanette Ferreira of the SU Department of Geography and Environmental Studies believes that a geographical analysis of the development and current state of wine tourism in the region can assist in the country's efforts to develop a new strategy to enhance and preserve wine tourism in the future. In a collaborative study led by Ferreira, wine tourism development was analysed from a nodes, network and winescape perspective using the results from a national questionnaire survey. This mostly quantitative approach explains the wine tourism development over more than 40 years from a supply-side perspective including its wine tourism product portfolio and in terms of its physical footprint. Wine tourism development commenced from only three pioneer open cellar doors in 1971, to network formation of 21 wine routes and today boasting well-established wine tourism destinations. "The Stellenbosch-Franschhoek-Paarl nexus emerges as South Africa's premier winescape, and hierarchical differentiation between the wineries of the more established wine tourism regions has materialised strongly," says Ferreira.

of sophistication, but ranks alongside spirits and beers in order of preference. Weightman also found that while wine purchasing is mostly convenience and price based, consumers still feel intimidated by the sheer number of bottles of wines on the shelves resulting in them choosing established brands and wines they have tasted before.

Other recent doctoral studies investigated the interactions between the three major groups of microorganisms in wine production on wine flavour. A PhD study by Dr Heinrich du Plessis (supervised by Prof Maret du Toit of the SU Institute of Wine Biotechnology), found that yeast treatment and malolactic fermentation strategies had significant effects on wine flavour and sensory profiles, especially regarding berry, vegetative, fruity and sweet associated aromas, as well as the acidity and astringency of wines. Colleague Dr Samantha Fairbairn, supervised by Bauer, investigated the defining chemical features of wine perceptions and of grape must composition on the chemical profile of volatile compounds at the end of fermentation. The data suggests that the 'wine' character that distinguishes wine from other beverages and allows consumers to categorise a product as wine, is entirely due to the metabolic activity of yeast.

### SA RESEARCH CHAIR IN INTEGRATED WINE SCIENCES

The Chair, held by Prof Florian Bauer, linked to the Institute for Wine Biotechnology, focuses on a better understanding of the microbiological transformation of natural raw materials into value added products such as wine. The Chair uses an extensive international network of collaborators to support a multidisciplinary research programme, which, besides microbiology and molecular biology, includes sensory, and data sciences, engineering and evolutionary biology. This programme is tuned to the needs of the SA wine industry, by investigating fundamental cellular and molecular processes of relevance to the broader life sciences, and by applying these insights to wine-relevant innovation. The assessment and exploitation of natural

microbial biodiversity, the understanding of population dynamics within natural lifestyle and industrial ecosystems, and the application of evolutionary engineering to individual organisms or ecosystems are also researched.

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## WORDS

An open-access cell phone application as well as a web-based trilingual technical dictionary, called MobiLex was compiled by the SU Faculty of Education in an effort to improve the academic literacy of undergraduate students.

The dictionary offers students the opportunity to look up terms that they find difficult to understand or that are unfamiliar to them in Afrikaans, English or isiXhosa. The dictionary provides terms in all three languages as well as a short, subject-specific definition in the preferred language. MobiLex currently has terms in education-related subjects as history, mathematics, natural sciences, geography, economic and management sciences, educational psychology, curriculum studies as well as academic literacy. Terminology from the Faculty of Theology has also been included.

"The better your vocabulary, the better your academic writing skills," says Dr Michele van der Merwe of the SU Department of Curriculum Studies. "The feedback we've received is that it is user friendly and helpful. Students use it in class, while doing revision and while studying. Mother-tongue speakers of all three languages have indicated that they make frequent use of MobiLex (available at [www0.sun.ac.za/mobilex](http://www0.sun.ac.za/mobilex)) for language support."



Researchers at SU have been involved in a global study of wine cycles in all countries that produce wine, to try and identify what drives cycles in wine production.

WINE [99]

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